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FAO EXPERT CONSULTATION ON FISHERIES RESEARCH

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FAO EXPERT CONSULTATION ON FISHERIES RESEARCH

Rome, 12-15 April 1994

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
ROME, 1994

PREPARATION OF THIS DOCUMENT

This Circular contains the background documentation and a summary of the discussion of an FAO Expert Consultation on Fisheries Research held in Rome, Italy from 12-15 April 1994. The following FAO Fisheries Department staff members contributed to the background papers and/or took part in the discussions: A. Bakun; J.F. Caddy; J. Csirke, J.F. Fitzpatrick, S. Garcia; R.J.R. Grainger; D.G. James; Z.S. Karnicki; C.H. Newton and M. Pedini. Dr W. Krone, Assistant Director-General a.i. (Fisheries) opened the meeting and the report was prepared by the Technical Secretary, D.G. James.

The Consultation identified priority areas for FAO involvement in research in the following fields: analysis of change in the world fishery situation; food policy for fisheries; small pelagic fisheries and aquaculture. Emphasis was also placed on the research needs to support UNCED, and research to support a code of conduct for responsible fishing. The priorities are included in the paper.

FAO.
FAO Expert Consultation on Fisheries Research
FAO Fisheries Circular. No. 877. Rome, FAO. 1994. 56p.

ABSTRACT

An Expert Consultation on Fisheries Research was held in Rome, Italy from 12-15 April 1994. The group of experts was called together to provide advice to FAO on the major research issues facing fisheries today and on how FAO could maximize its contribution to the research process, within the constraints on funding. The report contains the background documentation presented to the group, a summary of its discussions and research priorities identified for FAO in the following fields: analysis of change in the world fishery situation; food policy for fisheries; small pelagic fisheries; aquaculture; research needs to support UNCED, and research to support a code of conduct for responsible fishing. The priorities are included in the paper.

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CHAPTER I

1. THE PURPOSE OF THE CONSULTATION

The Fisheries Department of FAO was closely involved in the conduct of a Study on International Fishery Research (SIFR) which was published in 1992[1]. The purpose of the Study was to determine to what extent lack of research was constraining fisheries development; to evaluate capacities of developing countries to undertake the necessary research; and to seek ways to make donor support more effective in improving the research process. While the diagnosis provided by the Study suggests an urgent need for the strengthening of national research capacities, and greater use of regional research initiatives, it does not ascribe priorities, although it does identify many issues facing fisheries development where research would contribute to solutions.

FAO offered to provide increased technical support for the follow-up to SIFR and initiated a number of activities. The Expert Consultation reported here was intended to provide advice to FAO through calling together a group of experts for a wide ranging discussion on the major research issues facing fisheries today. The output from the Consultation will provide guidance to FAO on how the Organization's contribution to the research process can be maximized, within the constraints on funding.

FAO has always maintained a close involvement in all aspects of fisheries research and has made some significant contributions. In seeking to strengthen this role, there are a number of options which can be followed. These include: direct execution of strategic or adaptive research programmes; promotion of research to be carried out elsewhere (with FAO funding), or a more catalytic role in the coordination and management of international research programmes (e.g. through regional fishery bodies).

The discussions covered the full spectrum of fisheries research with the objective of consolidating those global priorities, within the FAO mandate, where the Organization should seek to concentrate its resources and thus to identify a rational mix of the various options for FAO's future involvement. The topics that were discussed are presented briefly below, with a more detailed coverage in subsequent sections.

2. WORLD FISHERIES TODAY: THE CONTEXT FOR FISHERIES RESEARCH

A brief historical background to fisheries development serves to identify some of the current and future global research issues. They must still, however, be disentangled from the administrative and political matrix. There is normally a feedback between research and management but there are also some issues that are not amenable to research solutions, and many cases where research results are not heeded for political expediency.

The expansionary period in fish harvests extended from the post-war period to the early 1980's. On the marine side most areas had reached plateaux by 1983, with catch

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[1] The World Bank/UNDP/CEC/FAO 1992. A Study of International Fisheries Research, World Bank Policy and Research Series No. 19.

increases restricted to only five stocks which, since 1989, have started to decline. Meanwhile fish catching capacity has continued to increase at a rate exceeding that of catch increases. Most significant has been the increased capacity of industrial fleets as few benefits from the extension of fisheries jurisdictions have accrued to the small-scale sector. In fact, the industrial expansion, coupled with limits on resource yields, has had negative impacts on numerous inshore fisheries; as well as creating a massive over-investment in industrial capacity.

Demand for fish has increased at least in proportion to population growth and is now forecast to exceed 140 million m.t. by the year 2010. The consequent effect will certainly be continued increases in real prices.

Most demersal stocks are overexploited and the long-term decline in Atlantic cod is particularly worrying, given the context of the high level of scientific research capacity available to North Atlantic fisheries. It is important for the future of fisheries research to determine whether the problem was that the alarm signals were not recognized, or that the advice was given but not heeded.

Inland fisheries are equally overexploited worldwide and show classic signs of overexploitation at the community level. The poor management of the resources has resulted in a drop in inland fish yields over the past few years. This decline, however, is not due only to fishing but to large scale environmental damage through pollution and physical changes to the ecosystem. In many ways inland fisheries are conditioned by the environment and much research is directed at techniques for mitigation of the impacts of unavoidable hydraulic works and the rehabilitation of aquatic systems where this is feasible. The decline in water available for fisheries has lead to efforts to intensify production from those waters remaining, either through aquaculture or culture based fisheries. Research is needed to catalogue, rationalize and disseminate these techniques.

The precarious position of marine and inland capture fisheries has focused attention on aquaculture as a potential source of the additional supplies to close the growing demand gap. Although aquaculture production has expanded significantly and there is still an upward trend, the growth cannot be sustained without strong research inputs. Selection of new species, suitable for aquaculture, genetic improvement of existing species, improved feed conversion and a better understanding of pond dynamics are among the requirements.

Improving the utilization of fish and reducing post-harvest wastage is another avenue to increasing availability. Historically the introduction of new technologies, such as canning and freezing, and subsequently freezing at sea, have contributed significantly. While technological leaps of this magnitude are unlikely in the near future, there is still scope for investigations to improve both the quantity and quality of fish products. There is also a need in the capture fisheries sector for fishing technology research to make the process of capture more selective, taking into account geoclimatic and regional characteristics as well as the preservation of biodiversity.

The present world fisheries situation requires innovative approaches to fisheries development and management if fisheries are to continue to provide a sustainable source of food. These new approaches must derive from the institutional framework for research. In

this context a number of priority research areas, which are close to the FAO mandate, can be identified.

2.1 Global and regional analysis

There is a large amount of data being collected at national, regional and global levels. However, although national trends are analysed, there is at present no mechanism for detailed analysis of regional and global data. The results of such analysis could influence national fisheries management and development policies as well as having an immediate impact on national research priorities.

2.2 A food policy for fisheries

In most countries fisheries development strategies do not take into account a national nutritional dimension, i.e., how can a common property resource be exploited both for maximum economic and nutritional impact? The increasing demand for fish as food, the increase of real prices for fish and encroachment of industrial fishing into inshore areas have combined to reduce the availability of fish as food for the poorer sectors of many populations. Governments need to be made aware of the impact of their management practices, and socio-economic goals, on a culturally important component of the food supply. While the underlying problems are poverty and lack of empowerment, research is required to generate information at national level, on which informed choices can be made. The recognition of the importance of fish in the domestic food supply may, for example, persuade governments to give more prominence to this goal in their fishery development policies, rather than other objectives such as income generation from exports.

2.3 Small pelagic species for direct human consumption

More than fifty percent of landings of small pelagic species are converted to fish meal and oil for animal feed despite the fact that they could make a very significant contribution to human nutrition, at relatively low cost. There have been extensive efforts over the last three decades to improve their use for direct human consumption. However, the industrial process for manufacturing meal, with its low labour content, and its ability to process large quantities during seasonal abundances, coupled with the low purchasing power of potential consumers, has restricted food use as a competitive alternative.

In addition to the need for introduction of innovative technologies a better understanding of the natural, environmentally driven, fluctuations of abundance is required. Technological research must be seen as a component of a broader programme enabling developing countries to participate in ongoing international climate driven research activities. FAO's interest, on behalf of developing countries, is the potential contribution of these fish to the food supply and the social and economic consequences. Among the benefits should be interpretation of trends to provide early warning of future availability which will be useful both in immediate terms of food security as with the more long term aim of establishing a rational level of investment in infrastructure.

2.4 Constraints to aquaculture and enhancement

In terms of volume, aquaculture production is dominated by the production of freshwater fish (96 percent of all farmed fish), aquatic plants and molluscs. With the considerable constraints encountered with water quality in inland areas, and the competing uses of water resources, further expansion in the culture of the species currently being farmed becomes more difficult. Expectations for increased production from the marine environment, are constrained by the fact that the most advantageous species, in terms of selling price, are carnivorous with consequent demand for low-valued fish as feed. As noted above there could be policy conflicts in removing such resources from the food market basket available to the poor. Research into new species, adaptable to culture is an ongoing need, and in line with maintenance of bio-diversity.

2.5 UNCED and after

The publication of Agenda 21[2] as an output of UNCED provides the challenges for sustainable development, into the next century while respecting the environment. The oceans and inland waters are identified as a major part of UNCED and FAO will be expected to provide leadership on fishery matters. These are particularly emphasized in Agenda 21 in Chapter 15: Conservation of Biological Diversity; Chapter 17, Protection of the Oceans; Chapter 18, Protection of the Quality and Supply of Freshwater Resources; Chapter 31, Scientific and Technological Community, and Chapter 35, Science for Sustainable Development. The range of research required to backstop Agenda 21 is very wide and FAO will be forced to target its attention to those priority issues directly affecting its mandate for fisheries. To identify these an open discussion on the challenges is required.

2.6 Responsible fisheries

FAO has taken on the responsibility for the preparation of a Code of Conduct on Responsible Fisheries. While there is still need for further elaboration on the scope of the Code, there are obvious demands for research to support the drafting and particularly the implementation of a code.

It is proposed that a section of the code should deal with fishery research per se by establishing the conditions for international cooperative research programmes.

3. RESEARCH COMMUNICATION

There is a good evidence that a considerable proportion of the fisheries research that is undertaken is not converted into sound advice and subsequently acted upon for the benefit of fishermen and the community. Before insisting on the conduct of more research, it is important to discuss how the proper use of results by fishery managers etc. can be ensured.

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[2] Agenda 21: Programme of Action for Sustainable Development. Final text of agreements negotiated by governments at the United Nations Conference on Environment and Development (UNCED) 3-14 June 1992, Rio de Janeiro, Brazil. U.N., New York, 294p.

It is suggested that some of the answers may come through stimulating social and political research to understand the linkages which need to be made.

4. INSTITUTIONAL STRENGTHENING AND SELECTION OF PRIORITY AREAS FOR FAO

Responding to the issues set out above implies substantial requirements for institutional strengthening of research capacity in developing countries, including research information requirements.

The human and financial resources that FAO has available to support research are limited. The Consultation was encouraged to discuss how these could best be applied to the priorities. It was acknowledged in advance that identification of topics that could be coordinated by working groups, involving other interested institutions, could be a useful start.

CHAPTER II

SYNOPSIS OF THE WORLD FISHERY SITUATION

1. BACKGROUND

The growing crisis in fisheries is not a new phenomenon. As long as 25 years ago, FAO drew attention to the difficulties experienced by international fishery commissions, the problems of excessive fishing effort, subsidies and the need to reduce the costs of fishing. The warnings were contained in a Special Chapter on Fisheries in **The State of Food and Agriculture**: "The Management of Fisheries Resources". Since that time the problems that were apparent in the North Atlantic and North Pacific have spread world-wide and primarily concern difficulties of rational exploitation of common property resources. A further Special Chapter in 1980: "Marine Fisheries in the New Era of National Jurisdiction", analyzed the problems and opportunities in the era following the United Nations Conference on the Law of the Sea. This Chapter was optimistic for improvements in the management of fishery resources resulting from extensions in national jurisdiction:

> "The opportunity exists, as never before, for the rational exploitation of marine fisheries. Realization of the opportunity, however, will require major adjustments to the redistribution of benefits from the seas' wealth and improvements in the competence of the coastal States to exercise their newly acquired authority. The 1980s provide the threshold for a new era in the enjoyment of the oceans' wealth in fisheries."

In general, the redistribution of the seas' wealth has proceeded as anticipated, with a few coastal States gaining large benefits and a few distant-water fishing States incurring large losses. It was generally anticipated that with 95 percent of the world's fish resources now lying within the jurisdiction of coastal States, there would be a retrenchment in distant-water fishing fleets, but events by 1990 showed this not to be the case. Investment in large-scale fishing vessels capable of fishing great distances from port, and significant growth in fishing effort on the high seas beyond the 200 mile limits, continued.

With regard to improvements in the competence of nations to exercise their newly gained authority, developments in the 1990s have proceeded more slowly than anticipated. While coastal States with resources of interest to foreign countries have generally made considerable gains in managing their resources and extracting benefits from the foreign users, improvement in management of domestic fisheries has generally not occurred. Many coastal States viewed the extensions in national jurisdiction as an opportunity for fisheries development and indeed, the share of the world catch by developing countries exceeded that of developed countries by 1988.

In addition, environmental issues have become increasingly significant, posing difficult challenges. The major problems lie in the coastal zones where disparate uses from diverse sources are in conflict and where fisheries receive the brunt of the damage. The problems are particularly urgent for small-scale fishing communities in developing countries. There are also problems with fishing methods, such as the United Nations Resolution banning the use of large pelagic drift-nets, increasing concern with by-catches, discards and non-selective gears that include trawling.

The 1992 Special Chapter, entitled "Marine Fisheries and the Law of the Sea: A Decade of Change" reported on events up to 1990.

It showed that most of the increase in world marine catches came from five species, i.e. Alaska pollack, Chilean jack mackerel, Peruvian anchoveta, Japanese pilchard and South American pilchard, contributing 30 percent of the total catch by 1989. These species arerelatively low-valued species and together they contributed about 6 percent of the total value of production in 1989.

The rate of increase in world catches from 1971 to 1989 was 2.5 percent per year, lower than the rate of increase from 1950 to 1970, which was about 6 percent per year, but the steady increase, largely from these five species, masked the deterioration in a number of important species of groundfish and a general increasing dependence on other short-lived species. It was becoming apparent that the world's fish supplies increasingly relied on short-lived stocks, characterized by widely fluctuating yields as a result of natural variability and that appropriate attention was not being given to the conservation of the longer-lived, more stable yielding demersal species.

Overfishing has occurred in virtually all coastal States throughout the world, and recent examples of stock-rebuilding through reduced fishing effort has been shown to be effective.

Information available at the beginning of the 1970s already indicated that the fishery resources of the world had a limited potential and that this limit was rapidly being reached. However, between 1970 and 1989, the rate of increase in the world's fishing fleets increased at twice the rate of increase in world marine catches. The Gross Register Tonnage (GRT) increased by 180 percent, from 10 million to 28 million GRT and resulted in an overall catch increase of only 40 percent. The gap between fleet size increases and catches becomes larger if the 5 principal species are excluded, since the total catch of all other species increased by only 30 percent.

The consequences of such a fleet expansion, not just in terms of a reduction in catch per unit of effort, has been the enormity of the capital value associated with such a fleet size. The 1992 Special Chapter estimated the actual replacement value of this fleet to be US$ 320,000 million, representing, at a 10 percent return to capital, 46 percent of the estimated annual landed value of marine catches. The significance of this is the disproportionate share of the wealth from fisheries being absorbed by a fleet capacity that is in excess of what the fisheries resources can sustain. Evidence of the subsidies given to fisheries not only supports the expectations by governments for potential development of their fisheries, but also the economic *malaise* into which fisheries have entered.

Fishing costs as a percentage of the total revenue

	Estimated Fishing Costs in Million US Dollars	Costs as a % of Landed Value (US$ 70 000 Million)
Maintenance and repairs	30 207	43 %
Supplies and gear	18 506	26 %
Insurance	7 193	10 %
Fuel	13 685	20 %
TOTAL	69 591	99 %
Labour	22 587	32 %
Capital (10% of Replacement Value)	31 900	46 %
GRAND TOTAL	124 078	
Less: Total Revenue	70 000	
DEFICIT	54 078	

Source: FAO.

Associated with the increase in fleet size, has been the rapid technological change in the detection, capture and processing of fish. These innovations in fishing technology have allowed fleet fishing power to be executed rapidly, and to move from one fishery to another in short time periods. Full exploitation, which in the 1950s could take half a decade or more to reach, can now be achieved in the first year of a new fishery.

Although the number of under-exploited fishery resources available in the world has decreased continuously, there are still some available such as silver hake and mackerel in the Northwest Atlantic, horse mackerel and the anchoveta in the East-Central Pacific, krill in the Southern Oceans, and various species of squid in several areas of the world. Altogether, a further exploitation of known under-exploited fishery resources could lead to an overall increase in world catches of between 3 and 5 percent. There are, however, a number of constraints that make it unlikely that catches of these species will effectively increase in the

short- or medium-term. Furthermore, it would appear prudent to avoid expansion at this time, until the problems facing fisheries are appropriately addressed and rectified. Over-exploited fish stocks, such as Atlantic cod and haddock in the North Atlantic; octopus, sepia and squid in the East Central Atlantic; sardinella in the Southwest Atlantic and some notothenids in the Southern Oceans, require rebuilding. The increasing importance of shoaling pelagic species as a share of the total marine catch (33 percent) is not of direct benefit to consumers, since most of the catch of these species is converted to fish meal.

The increasing demand for fish and fish products will continue as a result of increases in population and incomes, which in the face of supply limits from wild stocks and environmental concerns over certain aquaculture practices, can be expected to sustain increases in the real prices for fish. Such real price increases are thought to be not only supporting the increasing fleet size, but allowing less-preferred species to occupy the market share previously held by the higher valued species of cods, hakes, haddocks, crab, salmon and shrimp, the last two now being cultured, but for which increasing supplies of cephalopods (as a substitute) are evident. Some price-quantity relationships by species are provided as well as relationships between deflated unit values and quantities for selected species for the periods 1970, 1978 and 1989.

It may be possible to conclude that since about 20 countries catch 80 percent of the world's fish production, corrective action to the world's fishery problems can be narrowly directed to these few, to relieve the present fishing pressure on over-exploited stocks. There is a fundamental problem in that the use-rate of fisheries is too high, fuelled by increasing world demand for fish supplies. It might be interpreted that the price of fish is therefore too low and does not represent the inherent costs involved in the conservation and management of stocks that is required. Certainly, the *per caput* availability of fish in developed countries is three times that of developing countries, indicating that aside from the over-exploitation of stocks in a number of developed countries, the price of fish from developing countries is lower. If developed countries are increasing their dependence on imports of fish supplies from developing countries because of lower prices, can this be a justification for declining interest in the state of their own stocks?

There is also a universal need to recognize that development of fisheries can no longer be viewed in terms of increasing production from wild stocks. A new development model is required for governments to adopt and this must also include adjustment to the fish production models and their targets (such as MSY) used for management. Implicit in the determination of an appropriate development model is the question of allocation. As an example, distant water fleets presently catch 45 percent (58 percent in 1989) of the total production off West Africa (Area 34). If attention was given to reducing the cost of catching fish and if the country closest to the resource base has the comparative advantage in costs, the development opportunities for West Africa would mean increasing national catches at a rate that would allow for stock-rebuilding but would mean phasing-out distant-water fishing activities. The removal of distant-water activities could be seen to be in the national interest for African food needs, resource sustainability and reduction in fishing costs, but will be dependent on the willingness of distant-water States to address the capacity problems of their fleets.

With the formation of the independent Republics of the former USSR, there has been a retrenchment in distant-water activities mostly as a result of adopting market principles for fleet operations. The distant water catch of the former USSR fleets has decreased from 9.2 million t in 1991 to 6.8 million t in 1992 and much of this catch is small shoaling pelagic fish. The impact of the withdrawal of these fleets on the catches off West Africa is already affecting food supplies in Africa and increasing the prices for fish. Yet development based on small pelagics, having such variability and consequent economic cycles, is not the best foundation. There is an obvious need for new technological advances.

For African nations to exploit their resources, while at the same time exercising conservation and management, will require a fundamentally different government approach. Such new policies must necessarily be based on information from research and more rigour in the management strategies. At the same time, the state of fisheries in the developed countries in the North Atlantic and North Pacific is cause for concern. For many years the investment in scientific research capacity has been high in these countries, but this is not reflected in the contribution to fisheries management.

Finally, it is increasingly apparent that analysis of fisheries issues around the world is no longer attracting the attention of non-governmental research. Is this the result of low funding priorities or the lack of progress in the national management of fisheries?

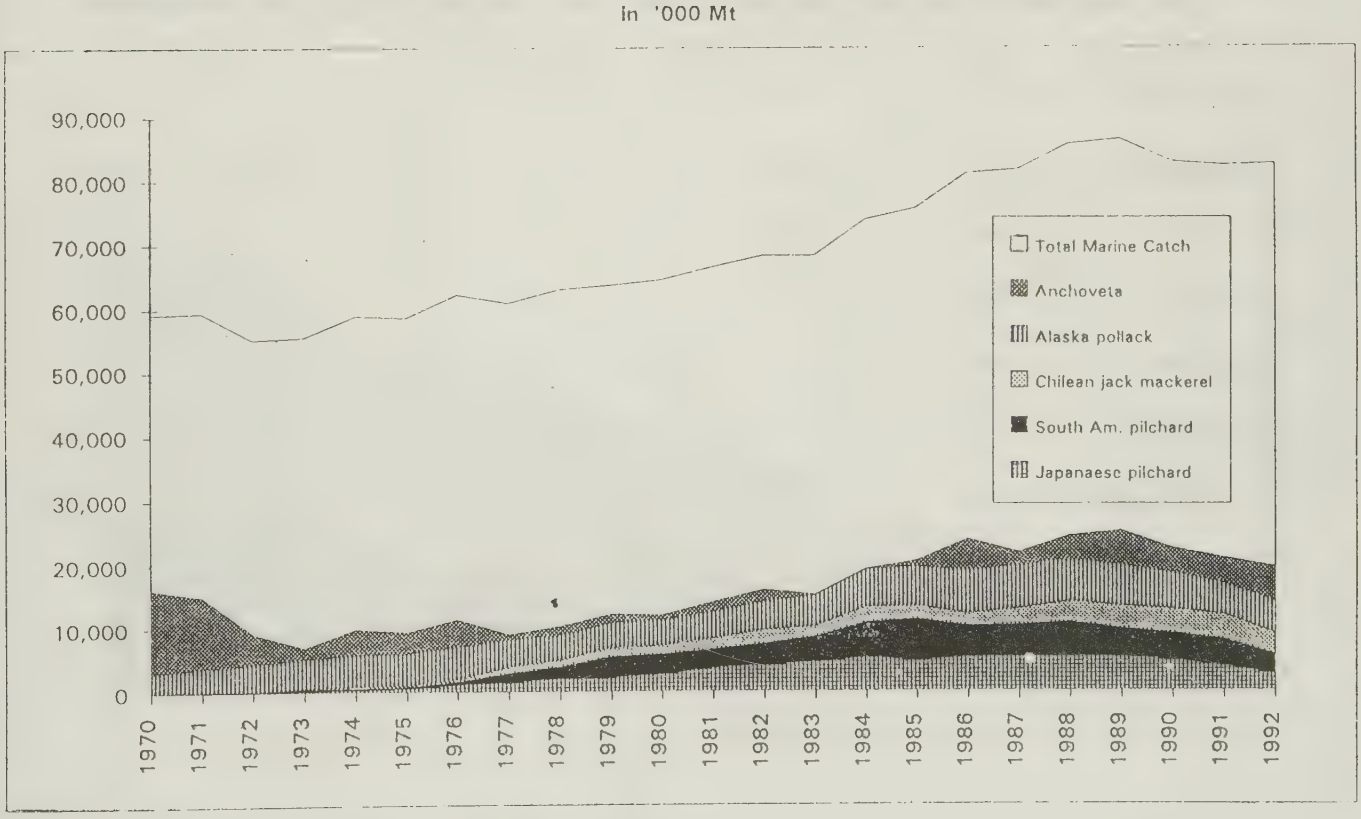


Figure 1 Principal species and total world nominal catch, 1970-1992

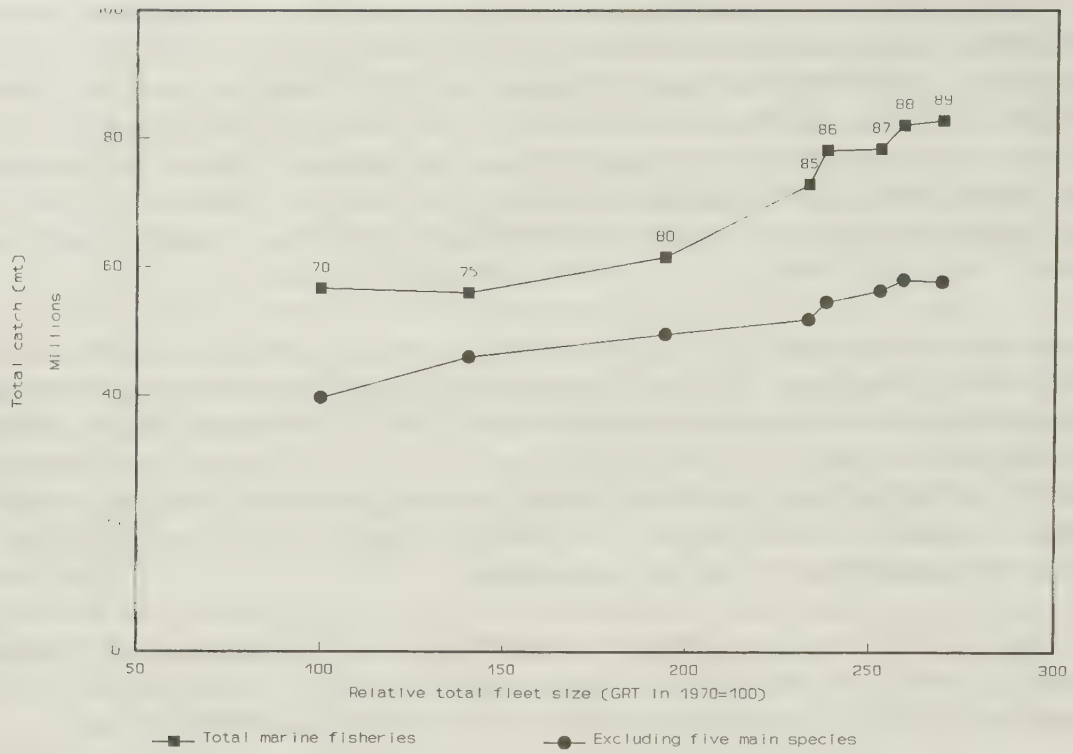


Fig.2 Relationship between the relative world fleet size (GRT of 1970 = 100) and the total catch of marine species and the total catch excluding main five species

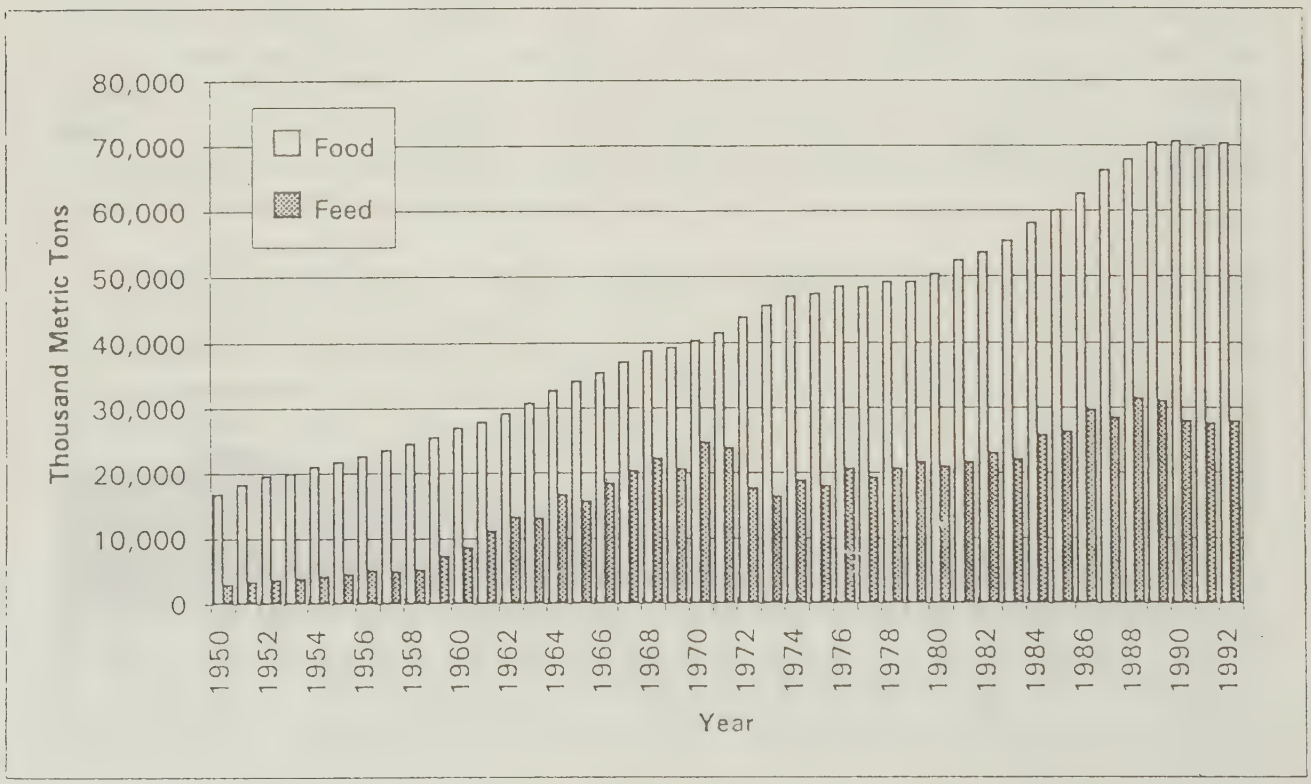


Figure 3 Total food and feed fish supply, 1950-1992

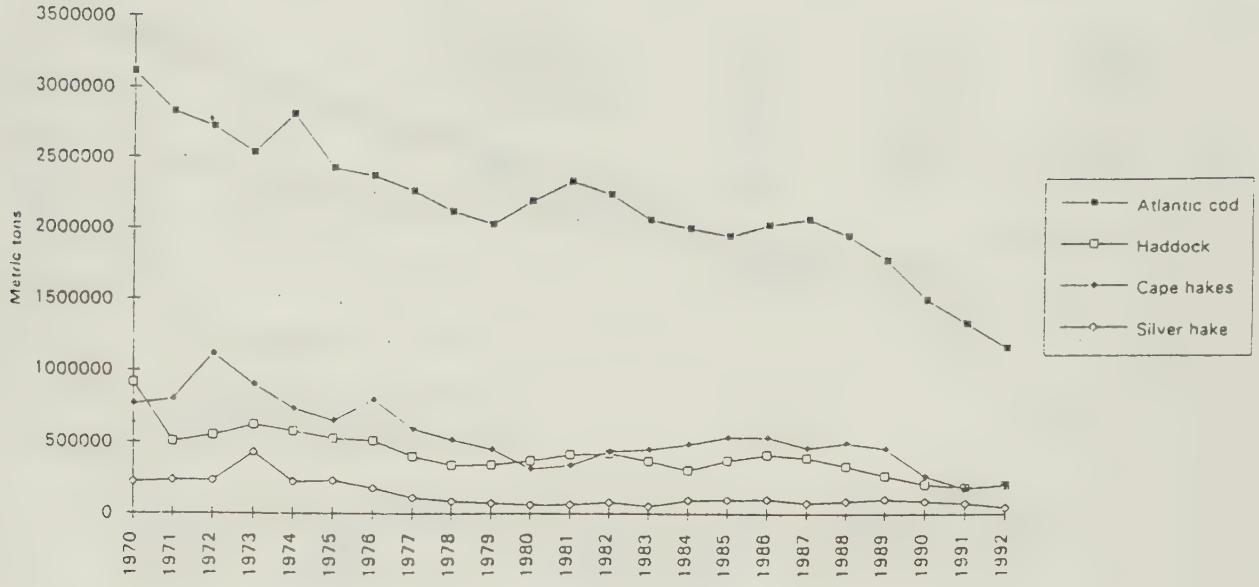


Figure 4 Catches of cods, haddock and hakes: 1970-1992

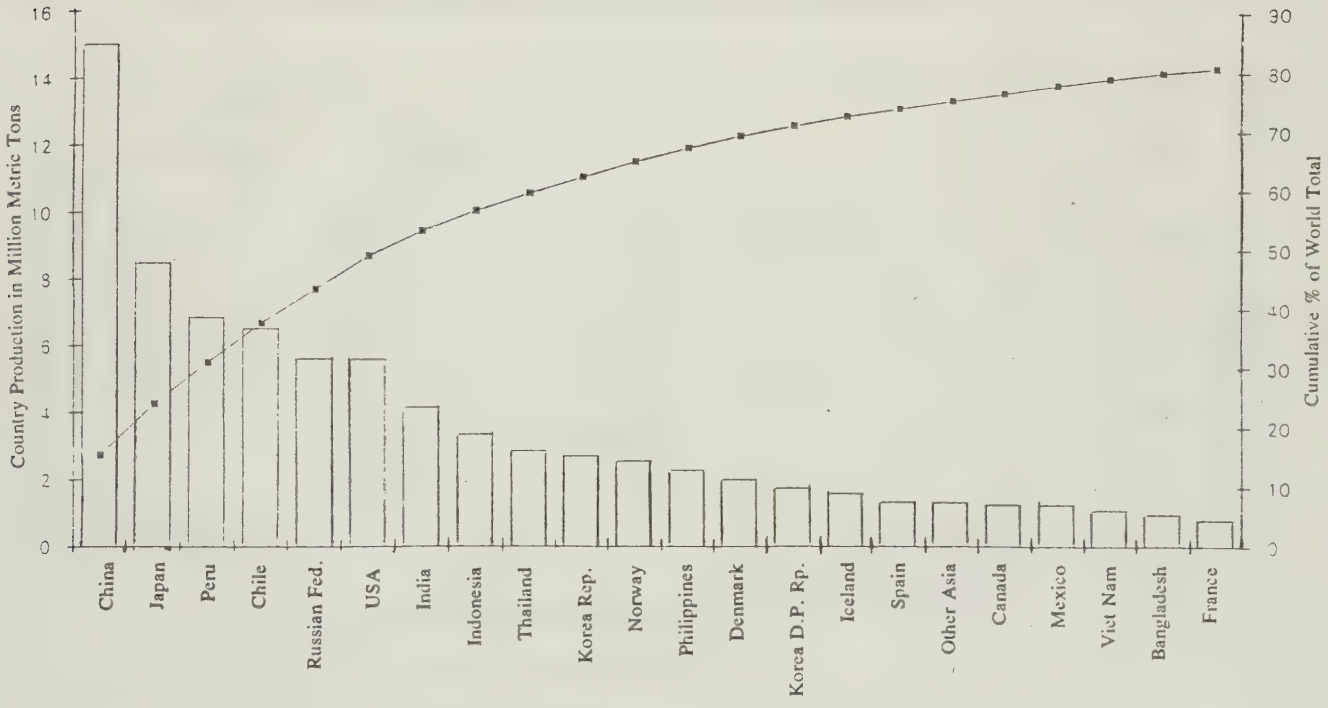


Figure 5 Total fish and shellfish production in 1992 by major producing countries

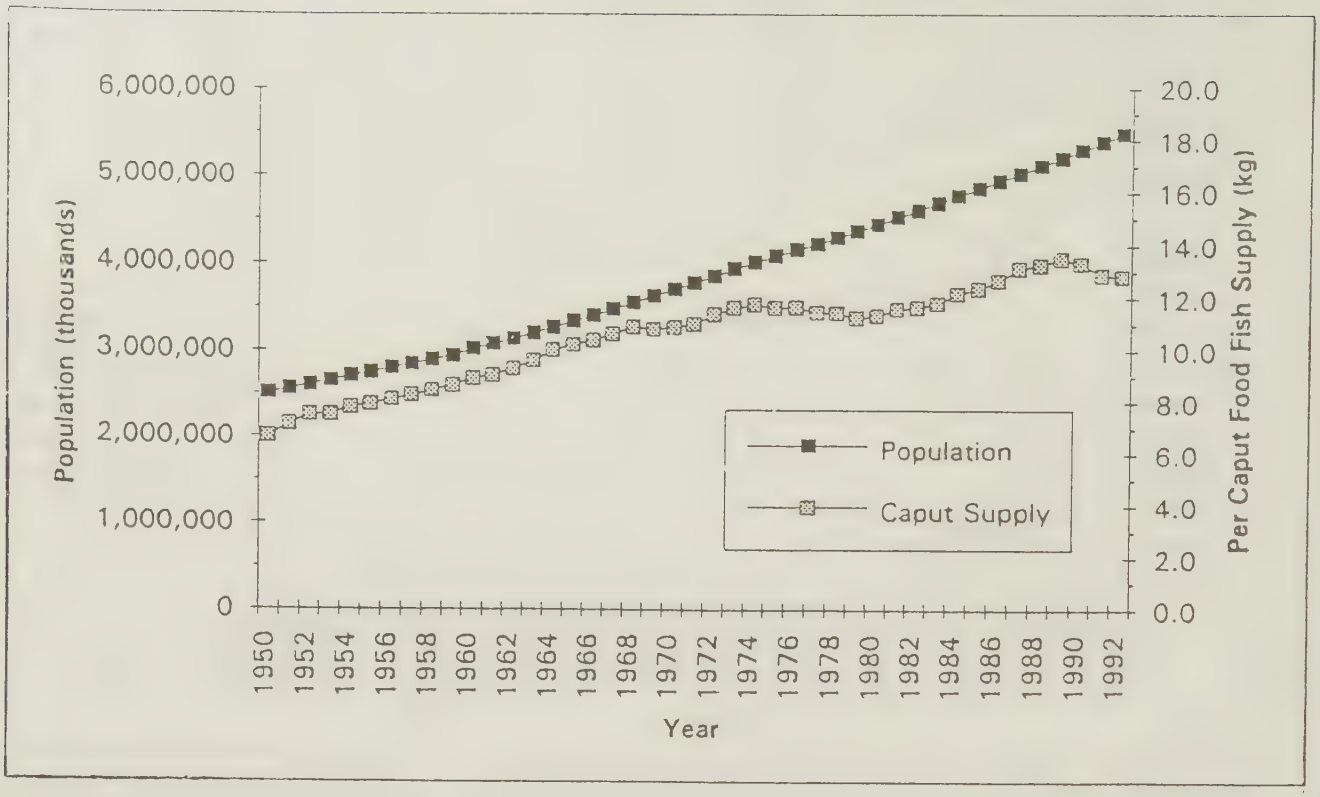
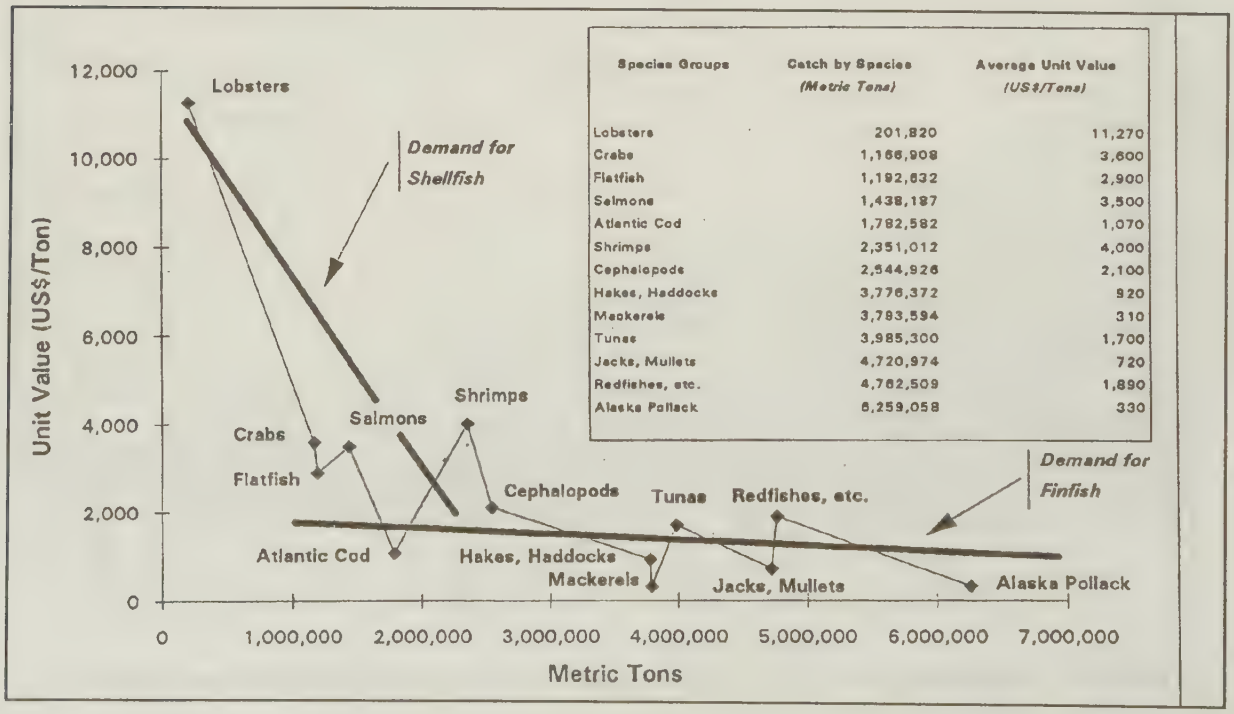
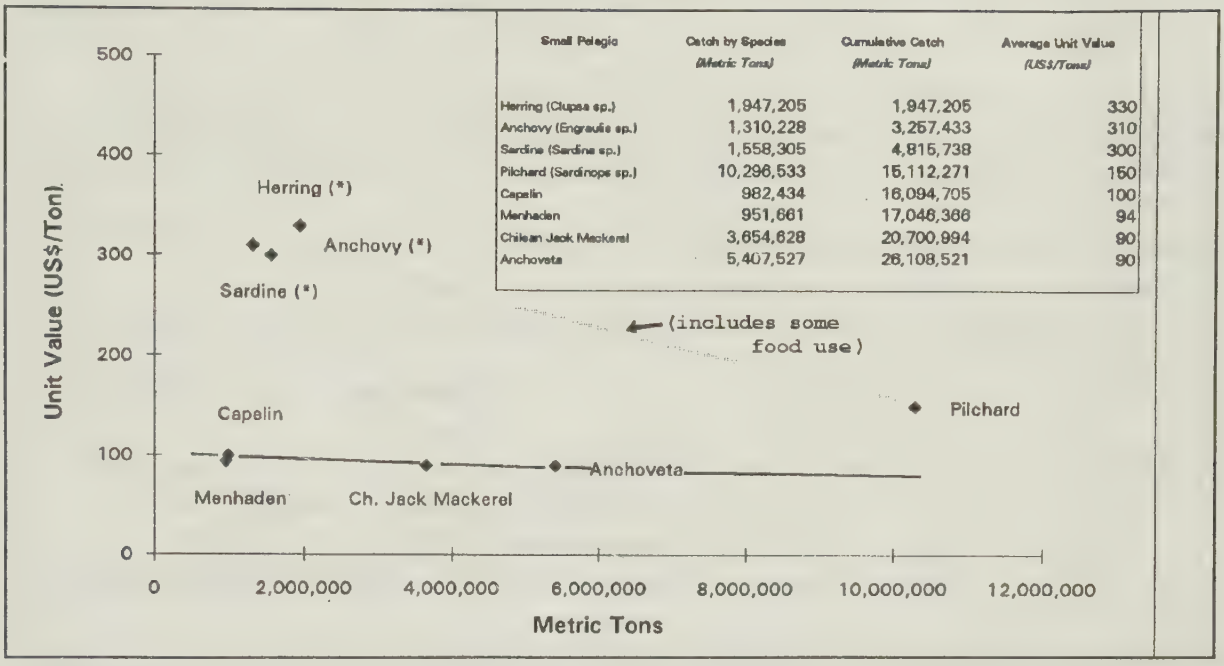


Figure 6 World population and per caput food fish supply, 1950-1992



Species Groups	Catch by Species (Metric Tons)	Average Unit Value (US$/Tons)
Lobsters	201,820	11,270
Crabs	1,166,908	3,600
Flatfish	1,192,632	2,900
Salmons	1,438,187	3,500
Atlantic Cod	1,782,582	1,070
Shrimps	2,351,012	4,000
Cephalopods	2,544,926	2,100
Hakes, Haddocks	3,776,372	920
Mackerels	3,783,594	310
Tunas	3,985,300	1,700
Jacks, Mullets	4,720,974	720
Redfishes, etc.	4,762,509	1,890
Alaska Pollack	6,259,058	330

Figure 7 Unit value and supply relationship of selected food fish species in 1989



Small Pelagic	Catch by Species (Metric Tons)	Cumulative Catch (Metric Tons)	Average Unit Value (US$/Tons)
Herring (Clupea sp.)	1,947,205	1,947,205	330
Anchovy (Engraulis sp.)	1,310,228	3,257,433	310
Sardine (Sardina sp.)	1,558,305	4,815,738	300
Pilchard (Sardinops sp.)	10,296,533	15,112,271	150
Capelin	982,434	16,094,705	100
Menhaden	951,661	17,046,366	94
Chilean Jack Mackerel	3,654,628	20,700,994	90
Anchoveta	5,407,527	26,108,521	90

Figure 8 Unit value and supply relationship of non-food fish species in 1989

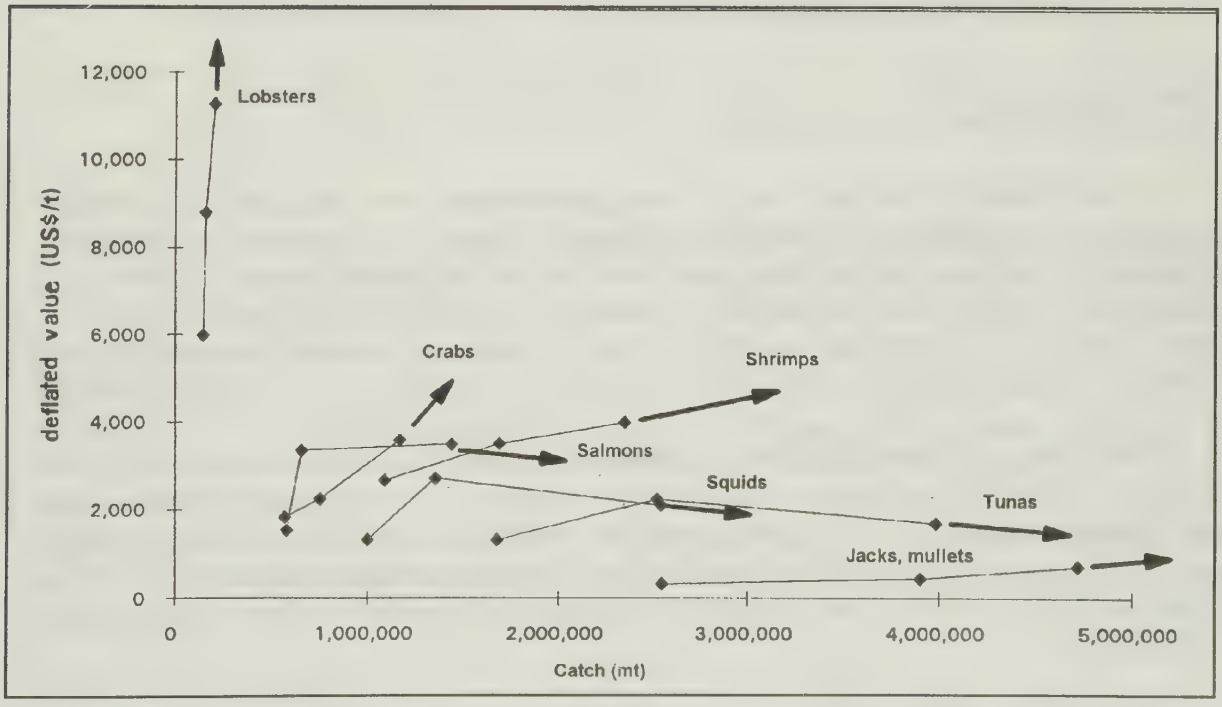
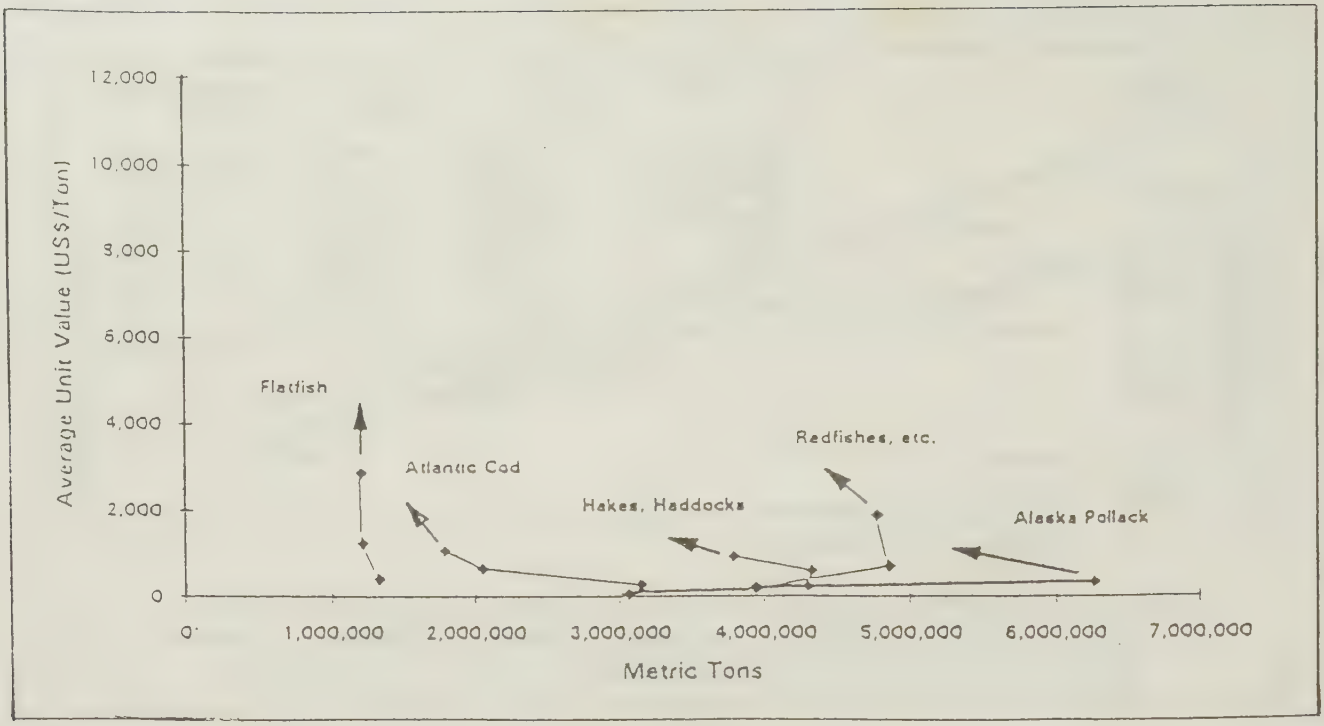


Figure 9 Relationship between deflated unit value and supply of selected species with potential expansion, 1970, 1978, 1989. Arrows show direction of expansion from 1970, 1978, 1989 and projection.



Arrows show long-run backward-bending supply projections.

Figure 10 Relationship between deflated unit value and supply of selected species with decreasing yields 1970, 1978, 1989. Arrows show direction of decrease from 1970, 1978, 1989 and projection.

2. DISCUSSION

In the discussion of this topic, it was acknowledged that the available scientific information is insufficient to enable an ecosystem approach to resource management. Difficulties are compounded by theory issues such as lack of property rights, the lack of political will to reduce fleet sizes and a lack of analysis of the impact of major policy changes. While it is clear that the benefits from extension of jurisdiction have not been achieved, it is also apparent that there has been a lack of analysis of what has gone wrong.

The Group considered that FAO's view of the world fishery situation was unique and that it was crucial that the view be expanded and enhanced. The continued collection and more detailed analysis of world fishery statistics would allow the identification of major issues in fisheries management and development. At the same time it would allow the transfer and application of experience gained in a region to the solution of problems common at a global level.

The major current issues identified during the discussion were separated into those related to the analysis of global trends and those concerned with the present system of data collection and analysis.

Major issues currently identified by analysis of global trends include:

There is good evidence that worldwide fisheries are suffering annual losses in excess of US$ 50 billion (or that governments are providing this level of hidden subsidy to continue fishing).

Inadequate data exists to examine the causes of the loss, including data related to the state of key fish stocks, world trade in fishery products, the role of technological change and the impacts of the end of the Cold War and the withdrawal of the Russian fishing fleet.

Major issues that need improvement in the current system of data collection include:-

Timeliness of the data and its analysis (currently there is a one year time lag)

Incomplete and inaccurate data

Data is limited mainly to production figures and does not include crucial data on prices, costs of production, markets, size of stocks etc.

3. RESEARCH TOPICS FOR FAO

The group selected the following research topics as being of high relevance to the FAO mandate.

(i) FAO collects a wealth of valuable data but should put more effort into its analysis to show the causes for failures and successes of fisheries management in order to draw lessons from the experience. The analyses should include both biological and economic aspects of fisheries.

(ii) Investigate and monitor world trade in fish products. If barriers to trade exist, they constitute a constraint to the development of fisheries in developing countries.

(iii) Continue and expand the existing work on fishery statistics, but expand the data set to include fishing effort (boats and gear), data on prices and costs of production, and long run predictions about the demand for fish as world income rises.

(iv) Investigate how regulatory devices and alternative fishing techniques might be used to encourage and assist subsistence fisheries.

(v) Investigate the range of property regimes applied by various countries to their fisheries, making an analysis of the history of their evolution and their relative success.

CHAPTER III

A FOOD POLICY FOR FISHERIES

1. BACKGROUND

Fish is particularly important as a source of animal protein in the diets of people in Asian and African developing countries. As human populations in these continents grow, there will be a major challenge to meet the estimated demand for food fish which will be of the order of 110 million tons per year by 2010. It appears inevitable that the present trend of sharply rising fish prices will continue as demand outstrips supply. Trying to ensure supplies for all has to be done in a manner which combines rational development and management with environmental soundness, economic viability and socio-cultural acceptability. A strategy of responsible fishing to achieve these goals should also give consideration to continued access to fish by traditional consumers.

While the ultimate reason for the pursuit of fisheries is as a contribution to the food supply, fish is not generally considered important in national food security as it contributes very little in the way of calories. Food security is defined in terms of per caput availability of staples (that is: food insecurity results when a country's grain reserves divided by population, yields a per caput daily availability of less than 2200 calories). Fishing is therefore more often seen as an economic activity, although the products do make a very significant contribution to nutrition through protein, essential fatty acids and micronutrients. The role of fish in food security tends to be more important at the level of household food security than at an aggregated national level. As the term household food security implies, among other criteria, access to a diet that is culturally acceptable and nutritionally adequate, the question arises of whether government policies could, or should, be directed to ensuring that fish remains in the food supply of traditional fish eaters.

For and against regulation

While the ultimate choice of whether or not to regulate access to fish is a political decision, the arguments against government intervention have usually been more appealing as they generally carry more economic weight. Although the case for regulation has a stronger moral and social component, it is rare that the interests of consumers have carried the day. As a result, there are very few instances where ensuring domestic supplies of fish has a higher priority in fishery plans than, for example, increasing export earnings from fisheries.

Those arguing for a laissez faire policy, and letting the market place decide, point to the almost complete failure of government efforts to control fish prices and to establish producer organizations in fisheries. While this is true, a policy of non-intervention is harmful to the poorer section of the community who after all, in a political sense, are stake holders in common property resources. They can rightly demand that they be consulted by government in the allocation of these resources. It is clear that protecting the rights of these people would require a search for effective government regulation, following a political decision to link fishery policy to national nutritional goals. It should be noted that there are surprisingly few countries with national nutrition policies, although access to staples at

equitable prices is often regulated. However, price controls, rationing, etc. are often unsuccessful in the long-term. It may be that a national nutrition policy, or at least national nutritional goals, is a pre-requisite for action in fisheries. The relative importance of fish in the diet would be another conditioning factor.

The lack of political power in the lower socio-economic groups constrains their demands for equitable access to many resources, including fish. Empowerment can result from a slow process of political awareness and change, which essentially comes from below, or it can be forced by legislation. The second is a more rapid, and potentially more hazardous approach which is wrapped up with human rights law. Rather than attempting to establish hard law it may be preferable, in relating fisheries to nutrition issues, to start with a dialogue between resource owners, users and managers. A code of conduct for fisheries development and management emerging from such a dialogue could include the following principles, in addition to already codified demands that resources should be exploited in a sustainable manner:

(i) fishery development policies should ensure that development projects and management strategies should do no nutritional harm to the community;

(ii) where there is some nutritional harm resulting from projects or policies, compensatory measures should be included so that the net result is no nutritional harm. (This might involve a trade-off between the direct value of fish as food and its commodity value when exchanged for cash which is subsequently used to purchase an adequate diet).

(iii) communities that are made vulnerable, either nutritionally or economically, as a result of fisheries policies should participate in the planning of projects, policies and management strategies.

Management

A suggestion to achieve results through a middle way, between no action and draconian government regulation, would be to build the principle of equitable access to the products of fisheries into management regimes. Open access to resources is blamed for the deplorable state of fisheries and the excessive competition which has decimated valuable food fisheries. There are many examples of degraded environments and overexploited resources resulting from fishing down the food chain. The consequence is landings of small fish and species unsuitable for human consumption which have a low unit value and are ultimately used as animal or fish feed. (The encouragement of intensive aquaculture is closely tied up with the same set of problems).

Fishery managers could ensure that the timing and extent of fishing effort was directed to produce fish with characteristics suitable for the domestic market. This would imply prevention of fishing of juveniles, closure of seasons until size, fat content and other condition factors had reached the optimum and other measures to give consumers a voice in management.

Countries with substantial small shoaling pelagic resources, coupled with demand for fish, could usefully consider how policy initiatives could result in exploitation of these resources for direct human consumption. It is ironic, at first glance, that up to one third of marine catches are destined for animal feed in the face of growing demand for food fish. There are technological and economic limitations, including decadal variations, which make exploitation difficult but it is clear that the major impediment is the lack of a coherent policy linking fisheries with nutrition.

2. DISCUSSION

In the discussion, it was acknowledged that fish prices will rise as a result of economics rather than government policies. The resources available result in an inelastic supply so prices will inevitably rise with demand. With scarce resources any non-market allocation, as a result of regulation, tends to introduce inefficiencies and wastes capital. With this in mind, it would perhaps be more reasonable for the disadvantaged groups to be identified and to benefit from transfer payments from society at large. This is a promising approach but one which still requires much debate on issues such as: how can the benefits from income earned by fish exports be transferred? Government responsibility on stewardship of resources, including fishery resources, should ensure that their use is paid for. The benefits could be converted into transfer payments.

A policy for fish as a source of food for direct human consumption must be situated within a longer national food policy. It also needs to be seen in the context of an economic security policy for the population of a country as a whole. In this regard, there are possibilities for increasing purchasing power by better integration of activities in coastal areas.

For fish to continue as a source of food, particularly for the poor, there must be an adequate supply backed by effective demand and a tradition of fish eating as well as an efficient distribution system. Above all there must be no lack of purchasing power as food security and economic security go hand in hand.

The discussion identified the following issues constraining an overall research programme before examining the priorities for FAO.

A policy for fish as a source of food for direct human consumption must be situated within a larger national food policy. It also needs to be set within the context and of an economic security policy for the population of a country as a whole.

For fish to become a source of food, particularly for the poor, there must be an adequate supply of it, backed by both effective demand and a tradition of fish eating.

Consequently, viewed on the global scale, the inability to satisfy existing nutritional needs, is more often than not, a problem of lack of purchasing power and fish eating nutritional habits rather than one of inadequate supply.

3. RESEARCH TOPICS FOR FAO

(i) Analyse various scenarios of the demand and supply of fishery products intended for direct human consumption and examine options to reduce national and regional imbalances.

(ii) Investigate the forms of technology and institutional arrangements that can be used in the harvesting, processing and marketing so as to ensure that product characteristics and their prices are acceptable to consumers with limited purchasing power.

(iii) Investigate the markets for fish to ascertain the price and non-price factors and market imperfections which are inherent in their functioning.

(iv) Examine the possibilities of tapping marine resources on the lower trophic levels which can substantially raise the overall availability of protein from the sea.

(v) Study the relationships between the technological and spatial issues in organizing the processing and marketing of fish which is destined for direct consumption by poorer consumers.

(vi) Analyse the scope of spatially dispersed inland culture fisheries integrated into farming systems to provide a more direct source of fish as food, particularly for the poor.

(vii) Research on the utilization of existing resources through minimization of discards, reduction of post harvest losses and utilization of hitherto under-utilized resources and by-catches.

(viii) Research on policies which articulate the role of fish in food security issues.

(ix) Assess the scope of providing appropriate fiscal and other measures to satisfy the demand for fish by the poorer populations in food deficit countries by changing the pattern of exploitation of small pelagic resources.

CHAPTER IV

SMALL PELAGIC FISHERIES

1. BACKGROUND

Recent research in fisheries biology, climatology and oceanography has resulted in a shift in our understanding of the dynamics of small pelagic fish populations in upwelling areas (principally in eastern boundary currents). Decadal scale non-random variability in abundance in sardine and anchovy populations are thought to be regulated by large-scale changes in oceanographic conditions (including El Niño events). There is evidence for so-called regime shifts during which different species replace each other (e.g. sardines replacing anchovies as the dominant small pelagic species). The characteristic time scales for these physically driven regime shifts vary geographically from about a decade to several decades. It is also generally accepted that heavy fishing intensity can accelerate stock declines and influence the nature and timing of such shifts. Climate change may cause changes in circulation and mixing that will influence the dynamics of these commercially important species. The environments of small pelagic populations in large tropical lakes and in inland seas are also changing due to eutrophication and modifications in runoff.

Small pelagics and marine ecosystem structure

Many marine ecosystems of the world share a striking aspect in the configuration of their biological community structures. They typically contain a very large number of species at the lower (e.g., planktonic) trophic levels. They also contain a substantial number of species (e.g., predatory fishes, large coelenterates, seabirds, marine mammals, etc.) which, as adults at least, feed at the apex or near-apex levels. However, in many of the more richly productive ecosystems of the world, there is often a crucial intermediate trophic level, occupied by small, plankton-feeding pelagic fishes. While this trophic level may also contain a fair number of species, it is typically dominated by only one, or at most several, species.

For example, the fish biomass of temperate coastal upwelling systems tends to be dominated by one species of sardines and one species of anchovy, and most often only one of the two is dominant at any particular time. Similarly, temperate ecosystems influenced by western ocean boundary currents may be dominated by a single sardine species (e.g., *Sardinops sagax* in the Kuroshio region near Japan), an anchovy species (e.g., *Engraulis anchoita* in the Falkand (Malvinas) Current of eastern South America), or a menhaden species (e.g., *Brevortia tyranus* in the Gulf Stream region off the eastern U.S.) Tropical analogs of these temperate ocean ecosystems tend to be dominated by analogous tropical species: sardinellas, anchovellas, thread herrings, etc. Other examples are the herring or sandeels of boreal shelf ecosystems such as the North Sea, the Bering Sea, etc., and the capelin of the subarctic Atlantic. The krill of the Southern Ocean may represent an invertebrate analog. Because of this typical community configuration, featuring many species at the bottom, many at the top, but constricted to a very few dominant species at a mid-level, these ecosystems have been referred to as "wasp-waist" ecosystems.

Certain modelling studies (Rice, in press) have indicated that variability in the trophic dynamics of these ecosystems may be largely dominated by variations in these mid-trophic level *wasp-waist* populations. Typically these populations of small pelagic planktivores vary radically in size, and these variations may have major effects on the trophic levels above, which depend on the small pelagic fish populations as their major food source, and also on the trophic levels below which are fed upon by the variable, but massive, small pelagic populations. Thus it is possible that the major control in these ecosystems is neither "bottom up" nor "top down" but rather "both up and down from the middle". The small clupeoid fishes that most often constitute the *wasp-waist* populations, feature notable "weak links" in their life cycles, such as periods of extended passive larval drift (e.g., Sinclair, 1988) or narrowly specific requirements for particular food particle sizes and types (e.g., Lasker, 1975,1978). Through these "weak link" life cycle features, the variability in the physical ocean-atmosphere system is able to exert a particularly direct control on the population dynamics of these species (Bakun, MS), and thus potentially on the trophic dynamics of entire ecosystems. Likewise, fishery impacts on these species would have similar ecosystem-level effects. Thus, research on small pelagics, in addition to its own specific utility, may present a particularly useful entry point for studying marine biological variability on a holistic ecosystem basis.

Sardine — anchovy interactions

Since the advent of large-scale industrialized fisheries, the dominant genus by tonnage in world fishery production has generally been either the temperate sardine, *Sardinops*, or the temperate anchovy, *Engraulis*. In systems where *Sardinops* reaches large populations, *Engraulis* always co-occurs. Both genera are notorious for population variability (e.g., Sharp and Csirke, eds., 1983; Kawasaki et al. eds., 1991). This variability does not generally have the character of random year-to-year variability about some mean state, but is characterized by multi-year or decadal-scale "runs". In such circumstances, conventional concepts such as "MSY", etc., become tenuous.

In the California Current region off western North America, the sardine fishery grew rapidly in the 1920s and 1930s, reaching peak landings of nearly three-quarters of a million tons in 1936. It collapsed during the 1940s and 1950s, and sardines practically vanished from the region from the mid-1960s to the mid-1980s except in "refuge" populations off the southernmost part of the peninsula of Baja California as well as within the Gulf of California on the other side of the peninsula. After a time lag of about a decade, the anchovy population increased with over 340,000 tons being taken in 1981.

In the Benguela Current system off southwestern Africa, extensive sardine fisheries began after World War II, peaked in 1968 at about 1.5 million tons, and then collapsed. Anchovy catches grew as the sardine catches decreased, reaching about 600,000 tons by 1974 and peaking at nearly 1 million tons in 1987; recently a precipitous decline has occurred. Indications from seabird diets, etc., as well as fishery landings, indicate that sardine is now replacing anchovy as the dominant population at the "wasp waist" of the Benguela ecosystem (Lluch-Belda et al., 1992).

In the Peru-Humboldt Current system off western South America, the fishery for anchovy (anchoveta) peaked in 1970 at more than 13 million tons. It then collapsed to less

than 1 million tons after the 1972 El Niño, rebounded briefly to about 2 million tons for several years, and then fell back following the 1976 El Niño to below 1 million tons and remained at this relatively low level to the mid-1980s. Sardine catches were low while the anchovy was abundant, but the population grew during the period of anchovy collapse to the point where nearly 6 million tons were taken in 1985, the highest yield of any sardine fishery to date (Lluch-Belda et al., 1992).

The sardine fishery off Japan has had two main peaks. It reached an initial peak of more than 1.5 million tons in 1935 and then collapsed. It remained extremely depressed for nearly three decades, when suddenly the population began to rapidly rebuild itself in the mid-1970s leading to annual fishery landings in the 1980s of over 5 million tons. Now the population appears to be collapsing a second time. The anchovy catches grew during the intervening period of low sardine abundance after World War II, attaining maximum levels of nearly half a million tons during the late 1950s and the 1960s. The anchovy catches then gradually declined as the sardine population proceeded in its rebuilding phase. Recently, as the sardine population is declining, extremely large shoals of anchovy are reported (Lluch-Belda et al., 1992)

Previously, there had been reluctance to denote these alternations as being actual replacements of one population by the other. Inconsistencies in the time lags were worrisome; sometimes the "replacement" did not begin to occur for a decade or more (i.e., at least several generation cycles) after the other population had collapsed to low levels. Moreover, in their analysis of annually-layered anaerobic sediments in the Southern California Bight, Soutar and Isaacs (1974) found that the numbers of deposited scales of sardines in their samples appeared to vary in phase with those of anchovies more often than they were opposite in phase. However, as more experience of observed regional-scale population variations has accumulated, with anchovies and sardines seldom being at high abundance levels at the same time, the evidence for at least some degree of actual replacement has become increasingly convincing (Lluch-Belda et al., 1992).

El Niño and global climatic teleconnections

The waters of the Pacific Ocean constitute one of the greatest masses of heat storage capacity on earth. The Pacific is so large that its atmosphere as a whole is only minimally subject to continental effects, and so is not nearly so strongly forced into seasonal climatic regularity as are the atmospheres of smaller, more continentally-influenced oceans. The result is that the coupled ocean-atmosphere system of the Pacific "wanders" from year to year, in response to its own internal dynamics, to a much greater degree than do other ocean regions.

The most dramatic expression of this interyear variability of the Pacific system is the El Niño - Southern Oscillation (ENSO) phenomenon. El Niño episodes precipitate by far the strongest interannual fluctuations in conditions affecting marine populations in the equatorial and eastern boundary regions of the Pacific. These deviations from the norm tend to be so radical that they totally dominate any other mode of variability. The largest fishery that has ever existed on earth, the Peruvian anchoveta fishery, collapsed in conjunction with an El Niño episode in 1972. Certainly, no fisheries scientist working in the eastern Pacific needs to be convinced that environmental variation is an important regulator of marine population dynamics.

Because the Pacific is so large, its effect on the earth's climate system is global. Accordingly, ENSO constitutes the dominant mode of short term climatic variability throughout the world. El Niño events have been associated with drought and catastrophic wild-fires in Indonesia and Australia, with both drought and flooding in different parts of Brazil, and with anomalies in monsoon rainfall and drought in India. Apparent linkages with climate anomalies in the central and eastern United States, western Europe, Africa, central Russia, China and Japan have also been indicated. The atmospheric and oceanic "teleconnections" that act to transmit ENSO-related effects to marine ecosystems distributed throughout the world's oceans have become well documented and reasonably well understood by the ocean science community.

Apparent global synchrony in fish population variability

The period of the Pacific-wide rise in sardine fisheries and the rise in the anchovy fishery in the southwestern Atlantic corresponded to a period of enhanced "El Niño" characteristics which began in the mid-1970s and lasted through the mid-1980s (Norton et al., 1985; Wooster and Hollowed, in press). During this period, the sardine (genus *Sardinops*) replaced the anchovy (genus *Engraulis*) as the predominant factor in world fishery landings.

This same decadal-scale period (early- to mid-1970s until about the mid-1980s) may strike some additional chords of recognition among fisheries scientists from various regions around the world. For example, this was a period of phenomenal productivity and growth of the major groundfish populations of the Subarctic North Pacific which sustained the massive expansions of the fisheries of that region through the period (FAO, 1992). Conversely, since the mid-1980s these populations are in incessant decline, in spite of continuing elaborate stock assessment activities and state-of-the-art fishery management efforts. It appears also to have been a particularly productive period in the tropical central North Pacific. Total chlorophyll in the water column appears to have increased north of Hawaii (Venrick et al., 1987). Lobsters, sea birds, seals, and coral reef fishes in the northwestern Hawaiian Islands all seem to have experienced increased production; since the period ended in the mid-1980s, lobster landings from this area have dropped by two-thirds (Anon. 1993).

While the events in the Pacific have been particularly dramatic, many correspondences can also be found in marine populations in the Atlantic. There is a tendency for opposite phasing of anchovy—sardine "regime shifts" in the Benguela upwelling system (Lluch-Belda et al., 1992) has been mentioned above. Moreover, the period of the early 1970s to the mid-1980s was the period of the triggerfish (*Balistes*) outbreak in the eastern tropical Atlantic, which was contemporaneous with a temporary suppression of the regional population of *Sardinella aurita*. It was also a period of increasing survival of Greenland halibut, a period of dramatic growth in the lobster landings in eastern Canada, a period of large increase in Newfoundland spawning northern cod stock, etc. Numerous other examples could be cited.

While no claim is made of any proven mechanistic connection, the degree of global correspondence and simultaneity of major marine population shifts is striking (Fig. 1).

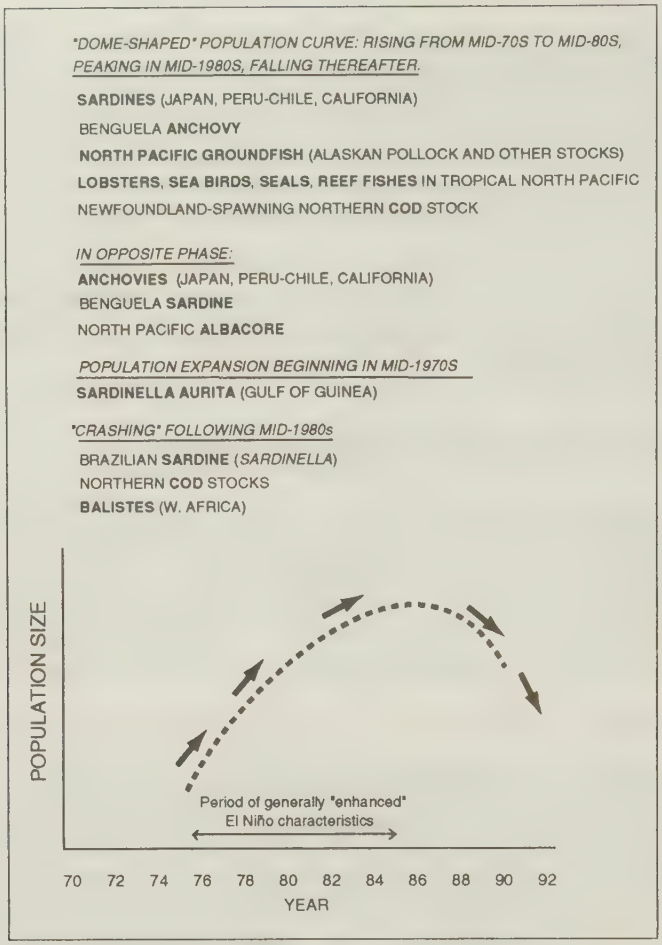


Figure 1 Diagram characterizing the pattern of variation, observed in many marine fish populations, showing a period of increased stock productivity and rapid population growth in the decade from the mid-1970s to the mid-1980s, followed by stock declines after the mid-1980s. Examples of various important fish populations whose stock fluctuations have been in phase with (or in opposite phase to) the pattern are listed (figure modified from Bakun, in press).

Importance to FAO

Nearly half of the total marine fish catch of the world is contributed by fisheries of small pelagic fishes. Because of the high variability of these populations, variations in total world landings tend to be controlled by the variations in the small pelagic fisheries. If indeed, the variations are mechanistically linked so as to occur in phase, there are obvious additional connotations with respect to security of the world's fish supply. Moreover, approximately 30% of the total world fish catch is reduced into fish meal and fish oil for use in animal feeds, most coming from small pelagic fisheries. Thus the consequences to world food security extend well beyond the supply of the small pelagic fish themselves as a food source for human consumption.

In particular, the rapidly-expanding development of aquaculture is dependent on the availability of a reasonably-priced fish meal supply. Fish meal and fish oil currently occupy the unique position of being essential dietary feed ingredients for all industrially-produced aquafeeds for cultured carnivorous fish, and to a lesser extent for omnivorous fish and shrimp species (Tacon, 1992). It is estimated that between 816 and 873 thousand tons of fish meal and between 190 and 205 thousand tons of fish oil was used in aquafeeds in 1990 (Chamberlin, 1992; Pike, 1991) or the equivalent of 13 to 15% of the world supply of fish meal and fish oil.

Indeed, as the world's population continues to expand, there is need for expanded supplies of fish for human food. In terms of conventional fishery resources, the prospect for continued increased production seems to be limited (FAO, 1992). However, there still remain certain pockets of unutilized small pelagics, e.g., a large population of *Engraulis anchoita* in the SW Atlantic, some smaller stocks of small pelagics in the SW Indian Ocean. The potential utility of these presently unexploited resources appears to depend mainly on economic and market factors, as well as on certain technological issues.

Beyond the few remaining underutilized stocks, the major source of additional food fish to be gleaned from conventional types of fishery resources, would seem to be by shifting some of the very large quantities of fish (mostly small pelagics) used in fish meal production to direct human consumption. This idea of course raises a large number of uncertain issues ranging over the entire spectrum of biological, socioeconomic, and political spheres.

The fact that large annual natural variability in small pelagic fish populations occurs on the inter-annual scale is well accepted. The fact that it is becoming apparent that equally large, or even larger, natural variability may occur on the inter-decadal scale presents an additional extremely important aspect to the problem. Particularly, with the decrease in the presence of large fleets from long distance fishing nations (LDFNs) some of the "elasticity" in the exploitation system is removed. Coastal nations, exploiting their own local stocks, experience much greater problems with resource variability than would LDFNs whose capacity could be relocated to alternative regional fishing grounds.

Clearly, FAO would profit from improved scientific insight with respect to a number of issues, including

1. What are the socioeconomic and market factors underlying the viability of fisheries established on small pelagic fish stocks? How do these vary temporally and regionally?

2. Should small pelagic fisheries be subject to different industrial development strategies than other types of fisheries? Taking into account recent changes in activities of LDFNs, what policy advice should be given to developing countries?

3. To what extent are small pelagic fish resources actually "sustainable", either in the conventional sense of MSY or in the sense of a "dynamic sustainability" (where the catch may oscillate on interannual scales due to population variability but do so in a way that the oscillations continue to be of rather similar magnitude and form)?

4. To what extent may the variations in small pelagics be actually "manageable"?

5. What are the consequences of (possibly globally-linked) decadal-scale variations in small pelagic fisheries to world commodity supplies and food security?

6. To what extent may the variations in small pelagics be predictable, and how might a useful predictive system be developed? If a predictive system is possible, how could it be usefully incorporated in the fishery management process.

7. What are the mechanisms which may link widely separated regional ecosystems so as to cause the populations to co-vary in phase?

8. What are the consequences to reasonably-priced aquafeed supplies for the continually expanding development of aquaculture?

9. What are the human consequences to communities dependent on small pelagic fisheries which are highly variable on decadal time scales? How might they best be mitigated?

10. What are the most appropriate governmental or institutional responses, on the local, national, and international scales?

11. What are the consequences of inter-decadal variability of small pelagic populations on other fishery resources sharing the same ecosystem?

12. To what extent could a "fish component", established within a Living Marine Resources Module of the Global Ocean Observing System (GOOS), validly interpret global patterns in variations of small pelagic fish populations as indicators of climatic and anthropogenic effects on marine ecosystems.

Research efforts presently underway

There are several somewhat independent multilateral research initiatives underway on the factors driving the population dynamics of these extremely important resources.

SARP: The Sardine—Anchovy Recruitment Project, which is co-sponsored by IOC and FAO under the joint OSLR Programme, has been underway for some eight years. While SARP seems to have been de-emphasized at IOC in the past several years, various scientists in Latin America, Europe, Japan and USA have recently expressed a desire for some sort of revitalization of SARP.

GLOBEC.INT: There is an interest in a small pelagics research programme within GLOBEC International. In addition, several principles in the SARP Programme have recently suggested substantial potential benefits in associating SARP with GLOBEC.INT.

SCOR WG-98: Working Group 98 on "Worldwide Large-scale Fluctuations of Sardine and Anchovy Populations" has been recently initiated by SCOR.

CEOS: The Climate and Eastern Ocean Systems project is sponsored by NOAA, ORSTOM, and ICLARM with participation by scientists of a number of different countries and regions.

ORSTOM (W. Africa): An important research focus on small pelagic resources of West Africa has been promoted and facilitated by ORSTOM.

Only the "CEOS" and "ORSTOM (W. Africa)" programmes presently include even minor components specifically addressing social-economic issues. It thus appears important to define and promote appropriate complementary social-economic research activities.

References

Anon. 1993. Why lobster boom is over. Fishing News International, March, 1993: 4.

Ardill, J.D. and M.J. Sanders (eds.) 1991. Proceedings of the Seminar to Identify Priorities for Fisheries Management and Development in the Southwest Indian Ocean. FAO Fish. Rep. 457. 196 pp.

Bakun, A. 1990. Global climate change and intensification of coastal ocean upwelling. Science 247: 198-201.

Bakun, A. 1992. Global greenhouse effects, Multi-decadal wind trends, and potential impacts on coastal pelagic fish populations. ICES mar. Sci. Symp., 195: 316-325.

Bakun, A. (In press) Global Climate Variations and Potential Impacts on the Gulf of Guinea Sardinella Fishery. Proceedings of the Scientific meeting on Dynamics and Uses of Sardinella Resources from Upwelling off Ghana and Côte d'Ivoire, Accra, Ghana, Oct'93.

Bakun, A. (MS) Patterns in the Ocean: Mechanisms of Physical—Biological Interaction Regulating the Dynamics of Marine Populations. 322 pp. (63 illustrations).

Binet, D., E. Marchal and O. Pezennec.1991. *Sardinella aurita* de Côte-d'Ivoire et du Ghana: fluctuations halieutiques et changements climatiques. p. 320-342.*In* P. Cury and C. Roy (eds.) Pêcheries Ouest-Africaines Variabilité, Instabilité et Changement. Editions de l'ORSTOM, Paris. 524 pp.

Chamberlin, G.W. 1992. Aquaculture growth and future prospects. Paper presented at the annual conference of the International Fishmeal and Oil Manufactures Association (IFOMA) in Cancun, Mexico, November 1992.

FAO. 1992. Review of the State of World Fishery Resources. FAO Fish. Circ. 710, Rev. 8. 114 pp.

Kawasaki, T., S. Tanaka, Y. Toba and A. Taniguchi (eds.) 1991. Long-term Variability of Pelagic Fish Populations and Their Environment. Pergamon Press, Oxford, New York, Beijing, fankfort, Seoul, Sydney, Tokyo. 402 pp.

Koranteng, K.A. 1991. Some aspects of the Sardinella fishery in Ghana. p. 269-277.*In* P. Cury and C. Roy (eds.) Pêcheries Ouest-Africaines Variabilité, Instabilité et Changement. Editions de l'ORSTOM, Paris. 524 pp.

Lasker, R. 1975. Field criteria for survival of anchovy larvae: the relation between inshore chlorophyll maximum layers and successful first feeding. Fish. Bull. U.S. 73: 453-462.

Lasker, R. 1978. The relation between oceanographic conditions and larval anchovy food in the California Current: Identification of the factors leading to recruitment failure. Rapp. P.-v. Reun.Cons. int. Explor. Mer. 173: 212-230.

Lluch-Belda, D., R.A. Schwartzlose, R. Serra, R.H. Parrish, T. Kawasaki, D. Hedgecock, and R.J.M. Crawford. 1992. Sardine and anchovy regime fluctuations of abundance in four regions of the world oceans: a workshop report. Fish. Oceanogr. 1: 339-347.

Norton, J., D.R. McLain, R. Brainard and D.M. Husby. 1985. The 1982-83 El Niño off Baja and Alta California and its ocean climate context. pp. 44-72. In: Wooster, W.S. and D.L. Fluharty (eds). 1985. El Niño North — Niño Effects on the Eastern Subarctic Pacific Ocean. Washington Sea Grant Program, Univ. Washington, Seattle. 312 pp.

Pezennec, O., and F.-X. Bard. 1992. Importance écologique de la petite saison d'upwelling ivoiro-ghanaéenne et changements dans la pêcherie de *Sardinella aurita*. Aquat. liv. Resour. 5: 249-259.

Pike, I.H. 1991. Increasing importance of aquaculture to the fish meal industry — estimated sales of fish meal and oil to aquaculture in 1990 over one million tonnes. IAFMM (International Association of Fish meal Manufacturers) Technical Bulletin No. 25. March, 1990, Potters Bar, England, UK, 12 pp.

Sharp, G. D. and J. Csirke (eds.) 1983. Proceedings of the Expert Consultation to Examine Changes in Abundance and Species Composition of Neritic Fish Resources. FAO Fish. Rep. 291(2,3). 1224 pp.

Sinclair, J. 1988. Marine Populations. An essay on population regulation and speciation. Washington Sea Grant Program. Univ. Washington Press, Seattle and London. 252 pp.

Soutar, A. and J.D. Isaacs. 1974. Abundance of pelagic fish during the 19th and 20th centuries as recorded in anaerobic sediment off the Californias. Fish. Bull. U.S. 72: 257-273.

Tacon, A.G.J. 1993. Feed ingredients for warmwater fish, fish meal and other processed feedstuffs. FAO Fisheries Circular No. 856. 64 pp.

Venrick, E.L., J.A. McGowan, D.R. Cayan and T.L. Hayward. 1987. Climate and chlorophyl a: long-term trends in the Central North pacific ocean. Science 238: 70-72.

Wooster, W.S. and A.B. Hollowed. In press. Decadal scale variations in the subarctic Pacific: A. Winter ocean conditions. In: R.J. Beamish (ed.). Proceedings of the International Symposium on Climate Change and Northern Fish Populations. Can J. Fish. Aquatic Sci.

2. DISCUSSION

The discussion recognized the importance of the small pelagic species, representing about 30 percent of global landings. This reinforces the need for a better understanding of the decadal scale non-random availability in abundance, and, if possible, their prediction. The environments of small pelagic populations in large tropical lakes and inland seas are also changing due to eutrophication and modifications in runoff. The impact of all these long-term environmental changes poses serious questions about population dynamics of certain fish stocks and calls into question the use of regulatory concepts such as MSY.

The landings of small pelagics on a global scale have been increasing during the past several decades, whereas those of groundfish have been declining. Fishing mortality for most small pelagics populations exceeds that required to maximize yield. There are, however, a few populations that are considered to be underexploited.

Rapid declines in abundance of small pelagics populations, under heavy fishing pressure during regime shifts, generates severe economic and social consequences. Because of high debt loans as well as immobile capital and labour, the abrupt variation in fish supply can create significant problems. Debt obligations cannot be met, and labour frequently cannot move to alternative employment, so that financial losses occur during the downside of regime shifts.

A key constraint to the development of intensive marine aquaculture is the reliability of a constant supply of fish meal (most of which is generated from small pelagics fisheries).

At present major shifts in species composition, and the "turning points" in runs of good recruitment, are not predictable, but there is some evidence that major changes in abundance of small pelagics, whether due to oceanographic forcing, overfishing, or eutrophication may have impacts on other components of the respective ecosystems.

The background documentation indicated that a number of research groups were active in the field. The Consultation considered that FAO could usefully form a working group to bring participants of these programmes together to exchange information.

Issues

- The landings of small pelagics on a global scale have been increasing during the past several decades, whereas those for groundfish have been declining. Fishing mortality for most small pelagics populations exceeds that required to maximize yield. There are, however, a few populations that are considered to be underexploited.

- Rapid declines in abundance of small pelagics populations under heavy fishing pressure during regime shifts generates severe economic and social consequences. Because of high debt loads, immobile capital and labour, the abrupt variation in fish supply creates significant problems. Debt obligations cannot be met, and labour frequently cannot move to alternative employment, so that financial losses occur during the downside of regime shifts.

- A key constraint to the development of intensive marine aquaculture is the reliability of a constant supply of fish meal (most of which is generated from small pelagics fisheries).

- At present major shifts in species composition, and the "turning points" in runs of good recruitment, are not predictable.

- Major changes in abundance of small pelagics, whether due to oceanographic forcing, overfishing, or eutrophication is thought to have impacts on other components of the respective ecosystems.

3. RESEARCH TOPICS FOR FAO

- Socio-economic and market factors determining the viability of small pelagic fisheries.

- In order to enhance the capability for prediction of trends, ongoing monitoring of the fish populations, the oceanographic environment, and the fishing activities is essential.

- The adequacy of monitoring for the diverse ecosystems supporting small pelagic fisheries needs to be evaluated.

- The accumulated data on small pelagic fisheries and their oceanographic environment needs to be analysed, using comparative methods, with the aim of generating understanding of the processes involved in population regulation.

- Coupled with existing understanding of variability in "demand", the unusual variability in supply for small pelagics fisheries requires extensive analyses for optimization solutions.

- Harvesting strategies, including the definition of reference points for conservation, need to be evaluated for fish populations characterized by decadal scale shifts in abundance. The studies should also include socio-economic issues such as investment strategies and labour mobility.

- The relative roles of small pelagics for national food security and commodity supply needs analysis.

- The consequences of inter-decadal variability of small pelagic populations on other fishery resource sharing the same ecosystem need to be evaluated.

CHAPTER V

AQUACULTURE

1. BACKGROUND

The promotion of aquaculture research has been one of FAO's concerns for several decades. Although the Organization does not directly operate any research centre, the promotion of aquaculture research has taken place through:

- the organization of expert meetings as fora to discuss progress in certain topics and to focus new research priorities, as well as suggesting actions to be taken

- regional and national projects which over the medium term worked on adaptive research, and

- through the working parties of various regional commissions where collaborative programmes in aquaculture research have been discussed.

With the changes experienced in the field programme of FAO in more recent years, the number of projects in aquacultural research of various kinds has been progressively decreasing giving space to consultations and other type of meetings which have spawned new research programmes for collaboration amongst institutions in developing and developed countries.

The SIFR follow-up

After the presentation of the report of the Study on International Fisheries Research, at the Second Fisheries Donor's Meeting held in Paris in October 1991, the donor community decided to implement the Strategy on International Fisheries Research. This was launched to design and assist in the implementation of the detailed action plans which had been recognized as important to foster fisheries and aquaculture development through research in the short and medium terms.

This initiative has been carried out in parallel to the creation of the new CGIAR Centre for Fisheries and Aquaculture at ICLARM, This CGIAR Centre is involved in long term strategic research and the FAO has also participated in the design as a member of the TAC of CGIAR. Both initiatives are considered complementary.

At the above mentioned meeting the agencies participating in the Steering Committee of SIFR, which includes FAO, were requested to take appropriate measures to propagate the results and conclusions of the study and to take specific actions to improve the indicative action plan for the different fields which were retained as priorities by the Study.

The FAO initiated a number of activities in collaboration with other institutions. In the field of aquaculture, initiatives were started in Africa South of Sahara, the Northern African countries bordering the Mediterranean, and Latin America. A proposal was also prepared for the donor community to fund a similar analysis in Asia. Although it is well known that Asia is the cradle of aquaculture and is the region contributing most to world aquaculture production, it was not possible to gather the funds required to complete the analysis. However, starting the analytical process in Africa, which is a simpler geographic area from an aquaculture perspective, has allowed the methodology to be tested without the difficulties which would have been encountered in Asia if the exercise had started there. The interest of the Organization in this analysis was obvious as it permits a better focus of the needs of the Member countries for the design of future programmes. It has to be mentioned that since the preparation of the Technical Conference on Aquaculture which was held in Kyoto, Japan in 1976, there has not been a general consultation with the countries regarding their views on aquaculture development and research.

The methodology followed in the follow-up of SIFR

In brief, the analysis of research priorities leading to the preparation of an indicative plan at regional and sub-regional level has tried to obviate the criticism of the Study for International Fisheries Research that there was little evidence of direct participation of the recipient countries in the selection of priorities, and a limited coverage of existing national capabilities for aquaculture research.

The strategy selected by the FAO has been to design an indicative regional action plan based on a screening and ranking of the national priorities as given by the countries through national studies prepared according to standard formats. To this end, the FAO designed a set of guidelines which were applied in Latin America, Africa south of Sahara and the Northern African Mediterranean countries to assist in the preparation of standard national reports which would contribute the opinion of the countries to a set of questions analyzing the status and prospects of aquaculture development and of aquaculture research.

This methodology was fully implemented in Africa South of Sahara, partially in Latin America, due to the lack of funds for the supervision missions, and to a lesser extent in the African countries bordering the Mediterranean. Action in Asia is awaiting the availability of funding.

Africa South of Sahara

The more advanced exercise for promotion of development oriented research through the organization of specific networks involved 12 African countries (Cameroon, Central African Republic, Congo, Côte d'Ivoire, Kenya, Madagascar, Malawi, Nigeria, Rwanda, Tanzania, Zambia and Zimbabwe) which produce about 50 percent of the total weight and about 85 percent of the total value of the 1990 aquaculture production in Africa. The national reports were prepared by national authors, briefed by a group of consultants, including staff from the ALCOM project, after which the same group of consultants prepared a synthesis and an Indicative Action Plan based on a comparative analysis of the national reports. These two documents were discussed at the Second Working Party on Aquaculture of CIFA which took place in Harare, Zimbabwe from 13 to 17 September 1993.

In summary the major priorities identified for aquaculture development by the countries in Sub-Saharan Africa are :

- Reorganize and strengthen extension services;
- Give access to credit to small-scale farmers;
- Improve technology development and transfer processes;
- Privatize juvenile fish production and state farms;
- Reorganize public administration;
- Promote specialized education of senior staff;
- Establish a good aquaculture data base;
- Promote education and training of medium-level staff

In terms of aquaculture research the major priorities as identified by the countries are as follows:

- Improve supplementary feeding strategy;
- Biology and farming of new local species;
- Improve organic fertilization strategy;
- Improve farmed species genetically;
- Establish research facilities;
- Promote socio-economic research;
- Intensify market research;
- Improve broodstock management;
- Study cage culture systems;
- Improve and promote integrated farming systems.

The consultants identified a number of other priorities which were not properly reflected in the comparative analysis as a result of the country coverage (no Sahelian countries could participate in the exercise). These are:

- Enhancement of small water - body fisheries;
- Integration of aquaculture in irrigation schemes;
- Development of marine aquaculture;
- Management practices in temperate areas of Africa.

Through a logical process the aquaculture development priorities, development constraints and research priorities were matched and classified into four broad development priority areas: (i) administration and management; (ii) aquaculture production; (iii) aquaculture information; and (iv) education of researchers. The research programmes which form the indicative action plan have then been designed to help meet the identified aquaculture development priorities in each of these priority areas, either directly or indirectly. Most of them have been formulated at the regional level to address constraints within and amongst the five agro-ecological regional (West, Central East and Southern Africa and the Sudano-Sahelian regions) and would be implemented through a network of existing national institutions which would be assisted by the international donor community. In each network there would be a lead centre responsible for the overall coordination and organization.

As a result of this process nine regional research programmes have been elaborated. They are grouped into short term (five years) and medium term (ten years) and were assigned priorities by the countries as follows:

Research Programmes	*Duration*	*Priority*
Information Centres	Short term	1
Socio-economics	"	1
Production indicators	"	1
Fertilization-Feeds	Medium term	1
Broodstock management	"	1
Small-water bodies	"	2
Irrigation schemes	"	2
New indigenous species	"	3
Marine aquaculture	"	3

These programmes have been validated by the countries at the Second Session of the Working Party on Aquaculture of CIFA and have been sofar elaborated only as project ideas. In the course of 1994 further discussions with the donor community are envisaged in the framework of SIFR to raise funds for the detailed formulation of the programmes. These formulations would imply missions to the individual centres which form the networks and would produce project documents to be endorsed by the donors interested in the specific activities. An agreement on the cost sharing arrangements for these missions is required.

Latin America

The study covering 19 Latin American countries is at a less advanced stage, but the main research topics have again been selected to create specific activity networks to work in a similar way as in the case of Africa South of the Sahara. The topics retained as general priorities and activity lines are:

- Marine shrimp culture. This topic includes: support to improve the bio-technical constraints that limit production (pathology, feeds and feeding); economic analysis for improvement of the profitability; marketing research; and, research on the evaluation of environmental impact of aquaculture.

- Diversification of production. This concerns the search for new species of seaweeds, molluscs and finfish with potential for farming in the area, as the Latin American production still depends on a few species.

- Extensive forms of aquaculture. This refers to enhancement practices in inland waters as well as to the management of coastal lagoons. In the first case research is required to monitor the impact of the enhancement practices on the communities exploiting the inland waters. In addition limnological research is required to tailor the management practices to the specific characteristics of the water bodies. Although experience exists in some countries it is felt that this is an area where there is a large potential, in particular in relation to the small water bodies rather than the large reservoirs. For the second area, coastal lagoons, the research elements would consist in the evaluation of the possibilities of inclusion of extensive forms of aquaculture to maintain the high ecological value of these areas, creating at the same time economic activities sufficiently interesting for the communities living on the lagoons.

- Rural aquaculture. Although this is a topic to which a lower level of priority has been granted by the countries, because of the failure in past years of many programmes to assist subsistence aquaculture. In recent times research is being carried out for the promotion of a form of rural aquaculture which is targeted on higher income rural farmers which would have more economic relevance than the old subsistence forms of aquaculture. This new form, of what could be called a sort of artisanal aquaculture, requires a focused analysis of the production packages to be proposed in the socio-economic context of the new target group.

- Pathology and nutrition. Although these themes have been given high priority in the context of shrimp culture, they appear to have validity also in the context of the diversification of production which has been pointed out as a clear development priority.

- Information. Although not a research area, it has been singled out (as in the case of Africa South of Sahara) as a priority area to support all the research topics selected in view of the deficient diffusion of information on aquaculture research in the region.

Northern African countries

The study covering the Northern African Countries is still being finalized. The study does not incorporate Libya due to logistic problems. It has been supported by the MEDRAP II project and IFREMER, and it is expected that it will reflect the three main groups of priorities of the three networks on Information, Environment and Techno-economic Aspects which have already been established in the Mediterranean.

2. DISCUSSION

The discussion identified a number of important constraints to aquaculture development which included:

- institutional inadequacies;

- poor quality and repetitive research in some developing countries;
- projects designed according to donors' priorities rather than national needs;
- lack of social considerations in the design of aquaculture programmes/projects;
- production driven development not necessarily tuned to market requirements and sometimes without proper consideration of other, more fundamental considerations, such as processing and distribution facilities;
- the promotion of certain types of aquaculture by feedstuff companies, which, though resulting in increasing production in the short term, may have doubtful long-term sustainability;
- lack of information on the real costs (including environmental impact cost, etc.) of aquaculture production;
- inadequate transfer of existing technology;
- inaccurate extrapolation of solutions to problems in temperate zone aquaculture to apparently similar problems in tropical zones;
- limited global supplies of feed ingredients (for example, aquaculture development has already caused some countries (both developed and developing), formerly exporting fishmeal, to become net fish meal importers);
- disease/water quality problems;
- aquaculture of carnivorous fish and shrimp currently utilizes marine protein resources in the form of fish meal or low value pelagic species which might be better routed towards direct human food availability.

In identifying certain topics of immediate importance, the Expert Consultation recognized that there were many others which needed to be addressed taking into account the specific needs of both development planners and producers.

The research areas requiring immediate attention included:

- diseases;
- water quality;
- general feed ingredient availability and fish meal substitution;
- marketing and distribution;
- improvement in experimental design and interpretation;

- analysis of farming systems for the design and integration of rural aquaculture programmes/projects;

- methods of production through the enhancement of natural feed availability and farm-made feeds.

3. RESEARCH TOPICS FOR FAO

The Expert Consultation felt that a holistic approach to several of these problems, particularly diseases, water quality and nutrition was appropriate, thus endorsing FAO's current philosophy. The establishment of a code of practice for responsible aquaculture, which incorporated socio-economic considerations was seen as a useful contribution from FAO.

Recognizing its resource limitations, but noting FAO's uniquely detached position, the Expert Consultation recommended that FAO:

(i) investigate how aquaculture research is conducted and applied;

(ii) encourage networking on research between regional, national and non-governmental organizations;

(iii) continue to monitor and provide guidance on research priorities;

(iv) collaborate in the identification of topics for long-term strategic research through the CG system;

(v) continue existing cooperation with ICLARM on databases (e.g. introductions, genetics/biodiversity, codes of practice/quarantine) and develop other possible areas of cooperation;

(vi) collate results of aquaculture research globally and disseminate them to scientists and planners, for information and to decrease unnecessary duplication;

(vii) 'translate' research jargon into information of use to producers;

(viii) assist Member States to improve standards of research;

(ix) provide assistance at an institutional level and utilize networking as a research quality control mechanism;

(x) promote adaptive research for technology transfer.

Finally, the Expert Consultation concluded that further discussion of these topics was desirable. This Consultation, as far as aquaculture research was concerned, could only be considered as introductory.

CHAPTER VI

APPLIED FISHERY RESEARCH NEEDS IN SUPPORT OF UNCED

1. BACKGROUND

In June 1992, 178 Governments met at the United Nations Conference on Environment and Development (UNCED), in Rio de Janeiro, to adopt 27 principles for environment and development, and a blueprint for action for global sustainable development into the 21st century (Agenda 21)[3]. These instruments of international cooperation reaffirm traditional goals of sustainable use of fishery resources (both wild harvest and aquaculture), and place fisheries in a broader context by "Recognizing the integral and interdependent nature of the earth, our home" (Rio Declaration).

This background looks briefly at the new issues in fishery research in the wake of UNCED. Although some cross references are made with inland fisheries issues, it concentrates on research in relation to Chapter 17 of Agenda 21 which deals with oceans and coastal areas. The new research required is characterized by an increased demand for environmental and socio-economic impact assessments in a context of high demographic growth, growing urbanization and drift of populations to coastal areas. It examines the scientific challenges to be faced including the need for better decision-support systems and improved understanding of resource dynamics and uses. It then very briefly outlines the types of research needed to face the implementation of the various programmes foreseen in Chapter 17 of Agenda 21 which deals with oceans and coastal areas.

The concept of sustainable fisheries development and awareness of the close links that exist between sustainable development and the environment have only been formally acknowledged at international policy-making level during the last two decades. These issues were already known to the scientific community but had not received adequate attention - particularly on the part of the technical and political authorities - until the UNCED Conference of Rio in 1992.

The Conference of Rio clearly reaffirmed that environment, on the one hand, and development and the elimination of poverty, on the other, were in fact two sides of the same coin. All fisheries development and management projects in the EEZs, on the high seas and for the use of the interface areas (ecotones) between the aquatic and continental environments should now bear this in mind.

The concept of sustainable fisheries development (and therefore of responsible fishing) implies that development should meet present needs while safeguarding supplies for future generations. Such a notion brings a number of questions to mind: How is it to be

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[3] UNCED 1992. Agenda 21: Programme of Action for Sustainable Development. Rio Declaration on Environment and Development. The final text of agreements negotiated by Governments at the United Nations Conference on Environment and Development (UNCED) 3-12 June 1992, Rio de Janeiro, Brazil. UN, New York, 294p.

implemented? How and how far can development be pursued without endangering the balance between fisheries and its natural resource base? What contribution can fisheries research make in these areas?

It is already apparent that environmental degradation is affecting the quality of sea food and the productivity of critical coastal areas such as mangroves, sea-grass beds, estuaries, lagoons and shallow bays the health of which is essential for sustainable development fisheries. The effects are particularly significant in enclosed and semi-enclosed seas. In inland waters, diminishing water quantity and quality as well as massive ecosystem degradation through landscape modification have brought about losses of fish stocks in most continents. Intensive aquaculture development is also creating environmental problems as well as competition with other uses of the coastal zone and its resources.

In this context, the challenge for fishery research appears to be to contribute effectively to: 1) maintenance of biological productivity, 2) rehabilitation of degraded fisheries resources and habitats, 3) enhancement of natural production, where possible, 4) reduction of waste, and 5) improvement of the socio-economic sustainability of the sector.

The following sections address the main aspects of research and development in fisheries, focusing on those aspects more directly related to UNCED and the research requirements of Agenda 21 with particular focus on Chapter 17 on oceans and coastal areas.

1. THE NEW CONTEXT OF FISHERY RESEARCH

The solution to many of the environmental problems of fisheries and aquaculture is mainly linked to the economic and policy choices made. The mandate of FAO's Fisheries Department, its experience in tropical habitats and developing countries, and its ability to tackle both the problems of applied research and those of development have equipped it to deal with the concept of sustainable development that was popularized by the Bruntland Report (1987) and incorporated by FAO into that of "Responsible Fishing". This concept is at the centre of the FAO Member Nations' concerns and of relations between protection of the aquatic environment and fisheries development.

While fishery ecologists and biologists are clearly responsible for examination of the living world and ecosystem dynamics, the key to understanding the behaviour of fishermen and fishing dynamics is to be found among the human and social sciences. If the fisheries sector is to respect its environment, it must be aware of the damage that it can inflict on this environment, of the need for measures that are economically viable and of the fact that the environment should be an integral part of its reference framework. The search for a better balance between the environment and fisheries therefore calls for an approach that draws from both natural and human sciences.

Experience has also shown that the stimulus for, and conversely the impediments to, rational fisheries management lie not so much on the technical level but more with the choices made by society, particularly with regard to access to fishery resources and allocation of their benefits.

Fisheries and aquaculture communities and their social and cultural fabric are under constant change. Social practices change under the influence of population pressure, technological innovations that are not always fully mastered and the globalization of issues and trade. Coastal fishing countries - not only in the developing world - have on the whole not yet found coherent answers to the problems of a too-often anarchical harvesting of their fishery and water resources, natural climate variations and the worrying prospect of global climate change.

Environmental economics

Natural aquatic environments and the oceans in particular, have long been considered as an inexhaustible source of renewable resources permitting exploitation based on short-term objectives, and this despite the repeated warnings from scientists and striking examples of major stock collapse. The vulnerability of fishery resources and their natural habitats in the face of poorly controlled harvesting is reducing the resource base and degrading the fishery environment.

However, the impact is unevenly spread in both space and time. The situation varies according to stocks and regions, but the usual situation is one of deterioration, only occasionally improvement. Everywhere, there is a possibility of violent conflicts of interest.

The deterioration of the natural habitats has also led to an increasingly rapid erosion of biodiversity. Given the potential economic importance of molecules for medicine and of the genes of the wild varieties of cultivated species, this erosion amounts to a loss of economic potential for the countries concerned. Given future climatic change, the reduction in "possible" genetic solutions to deal with the expected developments represents an inestimable economic loss.

A fully-fledged environmental economics sector is now growing in response to policy-makers demands for estimation of the economic value of the natural resource base and estimation of utilization and prevention costs against the cost of rehabilitating degraded production systems. The fishery applications of such research are, however, rare despite their obvious need for the documented formulation of rules and regulations to ensure an appropriate management of resources and environment, which is the only way to guarantee the sustainable development of fisheries.

Demography and coastal and urban concentration

Human population growth will continue to outstrip natural production capacity. High migration is expected towards coastal areas with accelerated urbanization in most developing countries, where almost half the population will soon be living in urban areas in contrast to only 50 years ago when most people lived in the rural areas.

These man-made environments pose enormous problems in terms of impact on the coastal production environment and in terms of employment needs and food security. These problems affect land-use planning in areas with very high population density that consume large quantities of resources, export wastes and used waters, occupy coastal land area

(sometimes in direct competition with the resources themselves) and for which the control of rising food needs and supplies is often a very difficult matter.

Peri-urban artisanal fisheries have sometimes adjusted to this new situation, while at other times they have simply disappeared. Many large urban areas have reached such proportions that rapid population and physical growth is self-propelled by the high birth rates. The fishery sector therefore faces an unprecedented challenge, having to find the means of helping to feed a growing population whose very growth is helping to destroy the sector's biological production potential.

There is a high level of dysfunctioning in social, economic and territorial systems that double their population every 10 to 20 years, which is a growth rate that land-use planning, infrastructure construction and traditional fishery management cannot match. Calls are increasingly being made for a return to decentralized management, reviving traditional rights and devolving powers to coastal communities. To succeed, however, this process requires social cohesion if it is to function properly, social cohesion which - at least as traditionally understood - is itself rapidly breaking apart.

Uncertainty and precaution

The properties of fishery resources, their "fluid" nature, the poor quality of fishery data, the limitation of scientific models and research funds, the inherent difficulty of research in the high seas and the fluctuations of economic parameters tend to limit scientific understanding of the fisheries ecosystems. This leads to a degree of uncertainty in the scientific, technical, economic and political information upon which managers and industry leaders base decisions which may not always be wholly appropriate. Errors may affect the basic fishery data used for analysis (measurement error), the parameters derived from such data (estimation error), the relationships between the different elements of the fishery system (process errors), (4) the way these relationships are mathematically represented (model error), (5) decisions that management take on the basis of such information (decision error) and (6) the way in which management measures are implemented (implementation error).

Research must contribute to the reduction of error and of the level of uncertainty even though management decisions will often be necessarily taken with less than complete and accurate information. An important and difficult task will be to promote decisions about the levels of impact (and risk) that are acceptable to society.

New guidelines and reference points are needed for a Precautionary Approach to ecosystem management, related to global stress indicators, resilience factors, habitat conditions, etc. Measures or scales of ecological stress need to be established and agreed upon if usable reference points are to be provided and effects classified as acceptable or not from an ecosystem point of view. Clarification is also required, for example, on the measure of "sustainability" for an ecosystem and on the definition of "reversibility" of an impact on it.

2. TOWARDS AN AGENDA 21 FOR FISHERY RESEARCH

Analysing the evolution of fisheries since the Stockholm Conference (1972) and more particularly since the adoption of the United Nations Convention on the Law of the Sea (UNCLOS), 1982), it would appear that, in order to ensure sustainability in the spirit of UNCED, fisheries would require remedial action, at international and national level. The actions which would require improved research are, for instance:

- Rationalizing fisheries to rehabilitate the resource base and improve economic performance, particularly through reduction of fleet size and fishing effort.

- Reducing economic waste and threat to endangered species by promoting increased selectivity of fishing gear and practices and by promoting better use of catches, keeping in mind the need to conserve species diversity.

- Improving high seas management, particularly but not only for straddling stocks.

- Enhance harmonization of environmental and development concerns, improving industry's awareness of environmental issues and developing standards for "acceptable" levels of impact satisfying both the environmental and development conditions.

- Addressing management problems related to non-consumption uses, sectoral interactions, resources allocation and environmental degradation in the context of integrated coastal areas management. In particular, developing policy and sectoral guidelines for practical implementation of coastal areas integrated management programmes and institutional systems for conflict resolution.

- Improving the information base, upgrading national statistical systems (particularly for artisanal fisheries and high seas) and applied fishery research institutions. In particular, promoting the analysis of bio-economic interactions (in the fishery sector and the coastal area), monitor aquatic biodiversity and genetic resources and develop national capacity to use geographic information systems (GIS).

- Promoting effective people's participation in management, and community-based management systems for artisanal fisheries.

- Taking uncertainty into account, promoting the acquisition of the required scientific evidence, recognizing limitations of data and understanding where appropriate. This implies improving institutional frameworks and decision-making procedures, supporting better science, testing cautious management strategies, promoting agreement on acceptable levels of impact based on such elements as resources sustainability, vital reproduction thresholds, reversibility, social and economic impacts etc.

- Improving understanding of the global climate change and related fishery environment changes (sea level and temperature, river flow regimes, coastal transgressions etc.) and on environmental impacts on fisheries production. In

particularly sensitive areas, analysing possible response and developing contingency plans.

The following sections identify, for each of the programmes contained in Chapter 17 of Agenda 21, the type of research that is needed.

2.1 Integrated management and sustainable management of coastal areas, including exclusive economic zones.

The objective of this programme is to promote Integrated Coastal Areas Management (ICAM) as the concept and framework within which coastal States will ensure sustainable development of the coastal and EEZ resources (and fisheries). This requires improvement of coastal data bases, national research capacity and implementation strategies.

2.2 Marine environmental protection

The purpose of this programme is, in accordance with UNCLOS, "to prevent, reduce and control degradation of the marine environment from sea-based as well as land-based sources, so as to maintain and improve the life support and productive capacities". Although fisheries are certainly not among the most environmentally aggressive industries in the ocean, countries will have to take steps towards a reduction of environmental degradation from fishing activities. Research is needed to:

Develop cleaner processing methods to reduce the impact of processing plants (including fish meal factories) on the coastal environment.

Investigate public health aspects of the impact of human settlement on coastal ecosystems particularly related to aquaculture and small-scale fisheries.

Promote research on (a) fish behaviour in relation to fishing gear, (b) gear impact on environment (e.g. trawl impact on bottom structure), (c) stock structure and spatial distribution and (4) technological research in order to promote development of "environmentally safer" fishing gears.

Improve gear marking technologies as a contribution to the reduction of the risk of "ghost fishing".

Promote research on safer methods for intensive aquaculture and, in particular, develop safer protocols for the introduction of new species.

Transfer/adapt methods used to study agricultural systems to develop strategies for the integration of aquaculture in rural agriculture.

Make an inventory of critical habitats to be protected from fishing and other environmental impacts (seagrass beds, coral reefs, estuaries, other spawning and nursery areas, etc.).

Elaborate and analyse feasibility of precautionary management approaches with due regard to social and economic consequences.

Continue to improve national and regional information systems and data exchanges. Promote the use of Geographical Information Systems to study interactions and competition for space and resources.

Introduce or strengthen environmental research relating to fisheries using the regional fishery body mechanisms, the FAO Advisory Committee on Fishery Research and the SIFR mechanism.

Develop new methodologies and adapt existing stock-assessment tools including stock assessment techniques and bio-economic models to measure economic impact of fishing and other activities on fisheries.

Contribute to the effort of identification of "Particularly Sensitive Areas" with particular relevance to fisheries production.

Develop a better understanding of the consequences of environmental degradation and climate change on fishery resources.

2.3 Sustainable use and conservation of marine living resources in the high seas

High seas produce only 10% of the world catch but they are the area of highest political and socio-economic conflict and environmental concern to conservation groups. It is the responsibility of coastal countries and distant-water fishing nations to ensure proper utilization and management. Following the impossibility at UNCED to reach consensus on some issues related to high seas resources conservation and management, an inter-Governmental conference is going on under UNCED auspices to deal specifically with straddling fish stocks and highly migratory fish stocks. The two Technical Consultations held by FAO, on Large-scale Pelagic Driftnet Fishing (Rome, 1990) and on High Seas Fishing (Rome, 1992) have made recommendations, the implementation of which would require:

Improving statistics on high seas fisheries.

Improving information available on status of high seas resources and fisheries, particularly through the development of Geographical Information Systems.

Strengthening the management-oriented research in regional fishery bodies, amending their terms of reference as required and improving international scientific cooperation at least on an ocean-wide basis and, if possible, at global level.

2.4 Sustainable use and conservation of marine living resources under national jurisdiction

EEZs produce 90% of the world catches but their potential is being gradually eroded by overfishing. FAO has been promoting international efforts towards fisheries rationalization since its creation in 1945 and its role is widely recognized. Coastal countries have been given exclusive rights of use of EEZ living resources by UNCLOS and full responsibility for their management and sustainable development. Priority research demands relate to the need to reduce overcapitalization and correct overfishing. Other important objectives stated by UNCED include the need to restore resources to the level which could allow the maximum sustainable yield to be taken, to protect endangered species, to take into account the interest of local communities and small-scale fisheries. Research is needed to:

Continue to monitor the state of world fishery resources and the evolution of national management systems.

Improve understanding on resource allocation mechanisms and user rights as a basis for reduction of overfishing and overcapacity.

Improve national capacity in stock assessment and provision of management advice.

Develop management strategies compatible with local needs and with the capacities of developing countries.

Improve information on the EEZ phase of shared, straddling, highly migratory and high seas resources.

Develop environmentally-sound technologies for aquaculture compatible with water resources management plans, taking social factors into consideration and based on an assessment of environmental impacts, of alternative uses of water and of investment and operational requirements.

Promote the introduction of scientific data collection systems through monitoring, control and surveillance systems.

Study impacts of GATT agreements and trade barriers on the incentives for conservation of national resources and on national fish trade and food security.

Develop the research needed to reduce waste from fisheries by improving gear selectivity and fishing strategies, reducing discards and by-catch and promoting greater use of catches for human consumption.

Study interactions between fisheries and the other sectors, in the coastal areas as a means to promote integrated coastal fisheries management in inland areas as part of integrated river basin management.

Identify components of biodiversity important for conservation and sustainable use through improved species identification and documentation of genetic resources of commercially-important or keystone species.

Develop standards concerning the wise and safe use of biotechnology and genetically modified organisms in fisheries and aquaculture.

Develop improved practices regarding introduction and transfer of aquatic organisms and collection of aquatic germplasm.

Improve data on stock structure and develop alternative fisheries management strategies based on genetic stock identification.

Document genetic variability in natural aquatic populations, as well as on farmed or domesticated species used in aquaculture.

2.5 Addressing critical uncertainties for the management of the marine environment and climate change

This programme is specifically designed to improve the capacity of coastal countries to deal with the issue of climate change and, in particular, to improve the capacity to forecast potential effects in the coastal areas of changes in water temperature, sea level, river flow regimes, atmospheric ozone concentration and other potential manifestations of climate change. Action is in two directions: 1) improving understanding of mechanisms involved in order to reduce the uncertainty about likely changes and their potential impact and 2) facilitating decision making and elaboration of contingency plans taking into account the remaining level of uncertainty.

Increase efforts towards understanding inter-annual variations in stock size and resilience and their relation with environmental factors.

Cooperate with other organisations dealing with research in this matter such as IOC (through the IOC-FAO OSLR programme), UNEP, IMO, WMO and IPCC.

Develop models on the basis of which scenarios could be elaborated as to potential effects of climate change in specific regions.

Focus on highly dynamic and productive areas (upwellings), river-driven continental shelves and island countries.

Follow the development of the Global Ocean Observing System (GOOS) in close collaboration with IOC, contribute to the development of the GOOS Module on Living Marine Resources and promote cooperation on the development of a Marine Fisheries, Resources and Environment Digital Atlas.

CONCLUSIONS

- **Focus on coastal zones**: more attention will be paid by fishery research to inshore zones environment and productivity mechanisms because these areas are the richest and the most important for the reproduction of fishery resources. They are also used for multiple and partly conflicting purposes with damaging consequences for productivity, for biodiversity and for long term sustainability of the resources uses.

- **Integration of research at the systems level:** integration is needed for planning, management and for multidisciplinary project implementation. Synergies and interactions between the various uses of the productive systems need investigating. The study of coastal areas, water basins, flood plains, etc. requires more diversified research and greater integration of the various disciplines: geomorphology and hydrology, biology, ecology, population dynamics, economics, sociology, cartography, etc. Integration of these research fields would be better done in the framework of pilot projects. **Policy research** should be developed as an aid to sectoral development planning.

- **Reinforcement of the role of socio-economy:** the paper stressed this need and the consequences of the present deficiencies. What is required is not just adding dollar signs on biological models but opening a real space for economic research in relation to management. There is a risk that Ad hoc interventions in response to critical issues are undertaken at the expense of the necessary long-term basic research.

- **Diversification of observational time and space scales**: Stock assessment at the regional or sub-regional level with one data point per stock per year, for example, is unlikely to prove sufficient for proper management. It is also necessary to deal with site-specific management problems and seasonal phenomena. In order to transform a relationship which fishermen now regard as conflictual, a solution is to help them tackle the problems that they face when trying to optimize their operations, working at their time and space scales. In the domain of biology, the study of microscale events (larval food availability) must be combined with mesoscale analysis of advection and larval transport. The mechanisms for long term interannual oscillations of stock abundance may be found in subtle modifications in seasonal patterns of environment and reproduction.

- **Understanding of resources and fisheries**: Research will have to address the multispecies and multigear aspects of fisheries and take into account the flexibility of fleet strategies. **An understanding** of resources and fisherman's strategies will have to be established in order to facilitate comparative research in fisheries systems performance and to determine the appropriate management units and strategies. Relevant species and gear interactions should be identified and quantified. Better collaboration with fishermen would lead to improvement in the data quality, and consequently to progress in more long-term basic studies based on them.

- **Development of fisheries environment research:** There is a need to study the vulnerability of coastal and inland water systems to external impacts, the separation of the effects of fishing, climate, pollution and restocking, which remains as problematic today as it was 40 years ago. There is a need to test the reversibility of the present degradations (by experimental management ?) and develop approaches for coastal and fisheries rehabilitation.

There is also a need to prepare models forecasting changes in resources abundance and distribution in relation to expected climatic changes. The relationship between natural production mechanisms of wild populations and environmental fluctuations must be clarified as it is the key to sorting out the effects of the different sources of fish stock fluctuations. **Geographic Information Systems** will become privileged tools for the integration and visualization of data spatial analysis.

- **Enhancement of coastal and inland resources:** The applied parts of fishery research will move closer to aquaculture for their mutual enrichment and better enhancement of the inland and coastal resources. This collaboration will also cover environmental conservation. Mariculture and environmental management should be integrated on the basis of new models and methods. In many areas rehabilitation of coastal and inland waters is required. There already exists a strong tendency toward intensive investment for "enhancement" of the coastal strip (e.g. artificial reefs). In the absence of an adequate framework regulating access to space and resources, investment constitutes, de facto, a mechanism for claiming of inshore resources which may work to the disadvantage of conventional users. Investigation is needed to evaluate the bio-economic impact of such enhancements at a time when research has yet to acquire the knowledge needed to evaluate their effect on fishery resources productivity and availability. A series of independent studies on the needs of aquaculture research is being carried out by FAO.

2. DISCUSSION

The goals and objectives set out in the Rio Declaration and Agenda 21 are both inspiring in their vision of human beings living a "healthy and productive life in harmony with nature" and daunting, with regard to requirements for achieving the vision. There are many requirements to be fulfilled by many segments of society, but clearly international leadership to develop the scientific knowledge and build the local capacity to meet the objectives of Agenda 21 is required. When fisheries are viewed in the broader context of ecosystems (including human beings), lack of scientific knowledge impedes achieving the vision worldwide. FAO's traditional role in promoting international fisheries science and capacity-building in developing countries makes it uniquely qualified to expand its role in the broader context of UNCED. Little progress will be made toward the UNCED vision without international cooperation and enhanced financial support for research and capacity-building in developing countries.

UNCED has given environmental issues high priority within many countries, international organizations and donor organizations. There are many new committees, planning efforts and other types of initiatives. Research programmes are being broadened in response to UNCED. For example, FAO is now addressing the effects of natural and anthropogenic environmental changes on fisheries. It has also placed a high priority on social and economic research on fishery systems. But although sustainable use of fisheries is clearly a priority part of the UNCED vision, it has received relatively little emphasis in these new initiatives, and there has been no significant increase in financial support. Planning for UNCED too often appears to assume that the scientific capability exists to fulfil Agenda 21, or that it should be developed independently of fisheries. Fisheries research has a long history of providing the scientific basis for sustainability. This research needs to be

expanded and broadened in the context of UNCED, rather than wasting human and financial resources to reinvent it.

While the Consultation strongly supports the broadening of fisheries research in the context of UNCED, it stressed the continuing need for traditional information about fisheries, such as stock assessments. The Consultation cautioned against the conclusion that current problems with fisheries (which are discussed elsewhere in this report) are primarily the fault of the underlying conceptual basis of fisheries science or that there are alternative approaches for the future that will not require information on stock abundance, productivity, yields, the economics of the fishing industry and other traditional information. A wide range of additional information will be needed as well.

The Consultation noted that much of the vision of UNCED lacks sufficient scientific specification to enable it to be used operationally. This is not surprising, since there are relatively few examples of operational frameworks for sustainable use of components of ecosystems, and none for sustainable use of entire marine ecosystems. Nevertheless, the UNCED vision must be specified scientifically and made operational, if it is to be fulfilled.

While FAO should make an important contribution to the UNCED vision, it must focus its effort to be effective. It must also develop arrangements with other international organizations, national Governments and donor agencies to maximize its effectiveness and avoid redundancy.

3. RESEARCH TOPICS FOR FAO

In light of the issues raised above, FAO should place priority on the following research topics:

(i) Resource assessments - This has been FAO's traditional role, and it is no less important in the context of UNCED.

(ii) Adding scientific specification and an operational framework to the UNCED vision - In particular, ecosystem management, precautionary and risk adverse approaches, and new "reference points" or performance indicators for sustainable use (biological, environmental, social, economic) need to be defined. The specification of ecosystem management should recognize that there are many sustainable (singular or multiple) use options for aquatic ecosystems which will virtually always change ecosystems from their pristine state to either a desirable, or at least an acceptable, state.

(iii) Research on the human subsystem - Human beings are part of ecosystems. More research priority must be applied to the economic and social consequence of sustainable use options; specifically, the nature of the demand for the fishery products in markets, and the nature of the industrial organization used to produce the products. The benefits from sustainable use depend greatly on the institutional arrangements for using information to make decisions, implementing decisions (e.g., enforcement), allocating opportunities to use the resource, and motivating desirable behaviour by the users.

Institutional aspects of sustainable development are a high priority for research.

(iv) Case Studies - During the Consultation, many examples of fishery management and aquaculture development successes and failures were discussed. It is clear that there are many valuable lessons. Priority should be given to scientific case studies including consideration of social, economic and institutional elements of the systems.

(v) Minimizing Waste and Environmental Damage - A significant portion of the catch from fisheries is not used. Disposal of the waste can have adverse environmental impacts. Fishing itself may have direct adverse impacts on the environment by causing physical damage to habitat or mortality to non-target components of the ecosystem. Priority should be given to a techno-economic and socio-ecological audit of fishing gear, starting with trawls which have replaced more selective fishing methods in several countries. More information is needed on the effects of trawls on habitat and multispecies ecosystems. In addition, research on beneficial uses of fish waste and alternative (environmentally acceptable) methods of waste disposal are needed.

In carrying out these research priorities, FAO and the fisheries science community in general, must be cognizant of the need for public education about fisheries. The problems associated with fisheries are receiving new media attention. The public needs a balanced perspective including the importance of fisheries (as a source of nutrition and economic development) and the identification of approaches to solve problems.

FAO should seek the support and cooperation of other institutions in the pursuit of these research priorities. For example, it should seek an understanding with the GEF to give fisheries appropriate consideration in projects that include aquatic ecosystems. It should also participate in the development of the Living Marine Resources module of the Global Ocean Observing Systems (GOOS). This is an appropriate way to reaffirm the need for worldwide fisheries data and improved (e.g., reduced time delay) access to the data. It is also a mechanism for arranging routine regional and global assessment of the status of fisheries, and collecting the ecological data that will be needed to understand, and possibly predict "regime shifts" (see discussion on small pelagic fisheries).

CHAPTER VII

FISHERIES RESEARCH IN SUPPORT OF RESPONSIBLE FISHING

1. BACKGROUND

The issue of a code of practice or conduct for responsible fishing was first raised at the Nineteenth Session of the FAO Committee on Fisheries (COFI) in April 1991. Subsequently an International Conference on Responsible Fishing, organized by the Government of Mexico, in consultation with FAO, adopted the Declaration of Cancún and requested FAO to draft an International Code of Conduct for Responsible Fishing, in consultation with relevant international organizations. The request was brought to the attention of UNCED in Rio de Janeiro in June 1992 and further supported by an FAO Technical Consultation on High Seas Fishing in September 1992. Following the agreement of the 102nd Session of the FAO Council, the Twentieth Session of COFI, in March 1993, considered the scope and contents of a Code and requested that a draft be presented for discussion by the 21st Session of COFI in March 1995. Subsequently the general principles were discussed by an Informal Working Group in Rome in February 1994 leading to a draft which will be further considered by a Technical Consultation in Rome in September 1994.

Six chapters with guidelines and annexes are intended as set out below:-

DRAFT GENERAL PRINCIPLES

Guidelines		Annexes
FISHING OPERATIONS - in EEZs - in the High Seas	1. 2. 3. 4. 5. 6. 7.	London Dumping Convention Protocol to the Torremolinos International Convention on Fishing Vessels Safety Standard Specifications for the Marking of Fishing Vessels Standard Specifications for the Marking of Fishing Gear Convention on Reflagging of Fishing Vessels MARPOL Others
FISHERY MANAGEMENT	1. 2. 3. 4. 5. 6.	UN Convention on the Use of the Sea Practices (Selected Articles) Guidelines on effort control Guidelines on fisheries protection/patrolling Guidelines on endangered species Guidelines on small-scale fisheries management Others

FAIR TRADE PRACTICES	1.	Cancún Declaration
	2.	GATT Decisions
	3.	Codex Alimentarius
	4.	Others
AQUACULTURE	1.	Code of practice for species introduction development
	2.	Guidelines for environment management
	3.	Others
FISHERY RESEARCH	1.	Guidelines for fishery surveys with foreign vessels
	2.	Guidelines for cooperative research
	3.	Minimum Standards for applied fishery research
INTEGRATION OF COASTAL FISHERIES IN COASTAL AREAS MANAGEMENT	1.	Guidelines on land-use planning
	2.	Relevant Conventions
	3.	UNCED Chapter 17A

While it is clear that fisheries research would necessarily be an integral part of the other five chapters, it was decided that there should also be a separate chapter on research. COFI suggested the three areas shown in the annexes section above but it is obvious that these are by no means the only issues to be covered.

2. DISCUSSION

The Consultation agreed that the explanatory guidelines to the proposed Code should include encouragement of the introduction of new technologies and of institutional arrangements needed for new areas of fisheries research. Data ownership and the sharing of data would also need to be codified and the flow of information into the decision making process expanded. All these demands being thrust upon fisheries research institutes implies an urgent need to build national research capacity where it is lacking. States should also be made aware that the long time-scales for fishery research and monitoring meant long-term commitments.

RECOMMENDATION TO FAO

It was suggested that the following basic principles could be the framework for a Code of Conduct for Fisheries Research. Explanatory guidelines would be attached to each principle.

CODE OF CONDUCT FOR RESPONSIBLE FISHING

Principles for Fisheries Research

1. States should assume the responsibility for the conduct of fisheries research and the dissemination of the results in order to provide the best scientific evidence available as a contribution to fisheries management and development.

2. States should develop the minimum data requirements needed to assess the health of fisheries and ecosystems and agree on guidelines for data collection.

3. States should at all times be in a position to provide an assessment of the condition of the stocks under their jurisdiction; including the impacts of ecosystem changes resulting from fishing pressure, climate variation or habitat alteration.

4. States should recognize that there are minimum standards for fisheries research and should strengthen national research capabilities to meet these standards.

5. States should support regional frameworks to facilitate research at a regional level and the dissemination of research results to other regions.

6. States should accept guidelines for the setting of management objectives, performance criteria (e.g. biological reference points) and linkages between management objectives and fisheries research.

7. States should adopt standard specifications and guidelines governing the conduct of research vessels operating or intending to operate in waters of States other than the flag State.

8. States should adopt standard specifications and guidelines governing the conduct of research vessels operating or intending to operate on the high seas.

9. States should conduct research into, and monitor, the seafood supply and the environment from which it is taken to ensure that there is no adverse public health impact on consumers.

10. States should take the lead in research to ensure that the pattern of exploitation of fishery resources encourages maximum utilization for direct human consumption and stimulate the research required to underpin food policies related to fisheries.

11. States should carry out studies on the selectivity of target species by fishing gears and on the behaviour of target and non-target species to the fishing gear, as a prerequisite for management decisions.

12. States should ensure that social and economic aspects of fisheries are adequately researched and that data sources are established for ongoing analysis and monitoring.

CHAPTER VIII

COMMUNICATION OF RESEARCH RESULTS TO DECISION MAKERS

Throughout the Consultation, the unique role of FAO in gathering data and translating it into a comprehensive form was stressed. However, the considerable difficulties in communication of research results was also pointed out. The opportunity was taken for a discussion on the issues and, although it was acknowledged that the problem is too vast and complex for early solution, the following points emerged.

There is a clear difference between delivery of scientific information and having it understood at an administrative or political level. It was agreed that research scientists would have to put considerably more effort into communication and presentation of their results if they were to remain credible. There must be strong links between applied research institutes and the administrative process of fishery management. FAO has a role in increasing the awareness of policy makers on the proper use of research results in their discussions. Feedback on this process should ensure the continued funding for research. There is also an important obligation to communicate research results to the public at large, particularly in view of the increased influence of NGO's, and their political leverage with politicians and administrators. It is important to provide accurate scientific information and clear options (based on good science) to all the interest groups. There is also a need to bring industry into the discussions in a structured way as there is a general tendency towards governments being responsible for management, data collection and assessment but with the costs of research and management being transferred to the industry. FAO was also encouraged to improve regional cooperation in fisheries research through such means as joint working groups and stronger networks. FAO should also strengthen its activities in the provision of research information which could be effectively delivered through the same networks. At the same time, the networks should have a deliberate policy of packaging and presenting information for the non-scientific users. By implication, the scientists should not only be writing up the results of their research for their peer group but specifically targeting other interest groups whether they be managers, politicians, consumer activitists or the general public.

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